DOCUMENT RESUME

ED 217 778 HE 015 163

AUTHOR McNamara, Patricia P.; Scherrei, Rita A.

TITLE College Women Pursuing Careers in Science, Mathematics, and Engineering in the 1970s.

INSTITUTION Higher Education Research Inst., Inc., Los Angeles, Calif.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE May 82
GRANT NSF-SED-80-7651
NOTE 240p.

EDRS PRICE MF01/PC10 Plus Postage.
DESCRIPTORS Career Awareness; *Career Choice; College Students; Educational Background; Education Work Relationship; *Engineering; *Females; Higher Education; *Mathematics; Minority Groups; Nontraditional Occupations; *Science Careers; Sex Discrimination; *Womens Education
IDENTIFIERS Cooperative Institutional Research Program

ABSTRACT

The characteristics and persistence of young women who entered college during the 1970s and expressed an interest in science, math, and engineering (SME) are examined. The study design includes: (1) trend analysis of changes in characteristics of the science-oriented freshman pool from 1971-1979; (2) a longitudinal study of the educational and occupational choices of 7,000 members of the freshman class of 1971 over an 8-year period; and (3) interviews with 30 professional women in scientific and technical fields. Four success measures were considered: planning at the time of college entry to pursue a SME major or career; earning a bachelor's degree in one of these fields; pursuing a related graduate degree; and (4) being employed in a SME-related professional field. A longitudinal analysis of graduation with a science degree, predictors of undergraduate success, family background, and marital and parental background are presented, and a profile of the interview sample is given. Reinforcers of an orientation toward science and math are identified, such as high school advising, role models, and research exposure. Higher education decisions and experiences during undergraduate years, graduate study, and professional study are then discussed, followed by an examination of choosing and pursuing careers (developing career awareness, the labor market, work experiences, and career goals). Barriers to scientific and technical fields are considered. Among the conclusions offered are: minority women are underrepresented in careers in science and engineering; engineering is more popular among women than science-related careers; and a strong high school background is reported among most respondents. Appendices include: CIRP Freshman Survey Form for 1971; HERI 1980 Follow-up Survey; and the interview protocol. (LC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED217778

COLLEGE WOMEN PURSUING CAREERS IN SCIENCE, MATHEMATICS, AND ENGINEERING IN THE 1970S

Patricia P. McNamara
and
Rita A. Scherrei, Principal Investigator

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Higher Education Research Institute

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

This research study was supported by a grant (SED80-7651) from the Research in Science Education program of the National Science Foundation.

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Higher Education Research Institute
University of California, Los Angeles

May 1982

HE015163

Table of Contents

		Page
List of Tables		iii
Acknowledgements		iv
Chapter 1	Introduction to the Study	1
	Design of the Study	4
	Major Findings	7
Chapter 2	The Trends Analysis	11
	Academic Background	15
	Parental Education	21
	Degree and Career Aspirations	24
	College Choice	40
	Conclusion	46
Chapter 3	The Longitudinal Analysis	49
	Graduation with a Science Major	53
	Predictors of Undergraduate Success	65
	Pursuit of Advanced Degrees	77
	Occupational Choice	88
	Conclusion	100
Chapter 4	Profile of the Interview Sample	105
	Age, Field, and Occupational Status	106
	Family Background	110
	Marital and Parental Status	119
	Conclusion	120
Chapter 5	Reinforcers of an Orientation toward Science and Math	121
	High School Advising	123
	Role Models	128
	Research Exposure	134
	Conclusion	136
Chapter 6	Higher Education Decisions and Experiences	138
	The Undergraduate Years	139
	Graduate and Professional Study	151
	Conclusion	165
Chapter 7	Choosing and Pursuing Careers	167
	Developing Career Awareness	167
	Entering the Labor Market	172
	Work Experiences	186
	Career Goals	192
	Conclusion	195

Chapter 8	Conclusion and Recommendations	197
	Barriers to Scientific and Technical Fields	199
	Recommendations	203
	Conclusion	210
References		212
Appendix A	CIRP Freshman Survey Form for 1971	214
Appendix B	HERI 1980 Follow-Up Survey	219
Appendix C	Interview Protocol	224

List of Tables

Table		Page
1	Representation of Black, Hispanic, and White Women among Recipients of Bachelor's, Master's, Doctor's, and First Professional Degrees in all Fields and in selected Fields: 1978-79	3
2	Distribution of Cooperative Institutional Research Program Participants by Race/Ethnicity and Sex: 1971, 1973, 1975, 1977 and 1979	12
3	The Trends Data Base: College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex: 1971, 1973, 1975, 1977 and 1979	14
(4-24)	TRENDS IN CHARACTERISTICS OF COLLEGE FRESHMEN ASPIRING TO CAREERS AND/OR MAJORS IN SCIENCE, MATHEMATICS AND ENGINEERING BY RACE/ETHNICITY AND SEX: 1971, 1973, 1975, 1977 and 1979	
4	Students Reporting High School "A" Averages	16
5	Students Reporting Participation in a High School College Preparatory Program	18
6	Students Reporting They Were Very Well Prepared in Mathematics and Science in High School	19
7	Students Anticipating a Need for Remedial or Special Help in Mathematics and Science	20
8	Students Reporting their Fathers are At Least College Graduates	22
9	Students Reporting their Mothers are At Least College Graduates	23
10	Students' Degree Aspirations: Bachelor's and Above	25
11	Students who Rate Making a Theoretical Contribution to Science as a Very Important Life Goal	27
12	Students who Rate Becoming an Authority in their Field as a Very Important Life Goal	29
13	Students' Career Goal: Engineer	30
14	Students' Career Goal: Scientific Researcher	31

15	Students' Career Goal: Physician, Dentist or Veterinarian	33
16	Students' Career Goal: Health Professional	34
17	Students' Career Goal: Businessperson	35
18	Students' Career Goal: Secondary School Teacher	36
19	Students' Career Goal: College Teacher	38
20	Students' Career Goal: Nurse	39
21	Students Reporting Academic Reputation was a Very Important Reason for their College Choice	41
22	Students Attending Universities as College Freshmen	43
23	Students Attending Two-Year Colleges as Freshmen	44
24	Students Attending Private Institutions as Freshmen	45
25	The Longitudinal Data Base: College Graduates who responded to the 1971 Freshman Survey and the 1980 Follow-up Survey by Degree Achievement, Race/Ethnicity, and Sex	51
26	The Longitudinal Data Base: Science Majors by Field, Race/Ethnicity and Sex	52
27	Field Distribution at Graduation of Students who Entered College Planning to Major in a Biological Science	54
28	Distribution of Students who Graduated with a Major in the Biological Sciences by Field Plans at College Entry	56
29	Field Distribution at Graduation of Students who Entered College Planning to Major in a Physical Science or Mathematics	59
30	Distribution of Students who Graduated with a Major in the Physical Sciences or Mathematics by Field Plans at College Entry	60
31	Field Distribution at Graduation of Students who Entered College Planning to Major in Engineering	62

32	Distribution of Students who Graduated with a Major in Engineering by Field Plans at College Entry	63
33	Significant Correlates of Attaining a Bachelor's Degree in the Biological Sciences: White Men and Women	66
34	Significant Correlates of Attaining a Bachelor's Degree in the Physical Sciences or Mathematics: White Men and Women	67
35	Significant Correlates of Attaining a Bachelor's Degree in Engineering: White Men and Women	68
36	Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in the Biological Sciences: Women	72
37	Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in the Physical Sciences or Mathematics: Women	74
38	Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in Engineering: Women	76
39	Advanced Degree Fields of Undergraduate Majors in the Biological Sciences	79
40	Distribution of Graduate Students in the Biological Sciences, Physical Sciences and Mathematics, and Engineering by Undergraduate Major	80
41	Distribution of Graduate Students in the Biological Sciences, Physical Sciences and Mathematics, and Engineering by Major Field Plans at College Entry	81
42	Advanced Degree Fields of Undergraduate Majors in the Physical Sciences and Mathematics	83
43	Advanced Degree Fields of Undergraduate Majors in Engineering	85
44	Occupations of Students who Entered College Planning to Major in a Biological Science	89
45	Occupations of Students who Majored in the Biological Sciences	90

46	Occupations of Students who Entered Graduate Programs in the Biological Sciences, the Physical Sciences or Mathematics, and Engineering	92
47	Occupations of Students who Entered College Planning to Major in a Physical Science or Mathematics	95
48	Occupations of Students who Majored in the Physical Sciences or Mathematics	96
49	Occupations of Students who Entered College Planning to Major in Engineering and of Students who Majored in Engineering	99
50	Distribution of the Interview Sample by Age and Race/ Ethnicity	108
51	Distribution of the Interview Sample by Field of Highest Degree and Race/Ethnicity	109
52	Father's Education at time Interviewee Entered College by Race/Ethnicity	111
53	Mother's Education at time Interviewee Entered College by Race/Ethnicity	112
54	Father's Principal Occupation by Race/Ethnicity	114
55	Mother's Principal Occupation by Race/Ethnicity	115
56	Number of Children in Family by Race/Ethnicity	116
57	Type of Undergraduate Institution by Race/Ethnicity	140
58	Institutions Interview Sample Members Attended as Graduate or Professional Students	157

Acknowledgements

We would like to thank Alexander W. Astin, president of the Higher Education Research Institute and director of the Cooperative Institutional Research Program, for providing us with access to the data for the trends and longitudinal analyses. We also want to express our appreciation to the Ford Foundation for its support of the 1980 follow-up study. Although these data were collected as part of the work of the Commission on the Higher Education of Minorities, they provided one of the major data sources for this project. Obviously, we are indebted to the National Science Foundation's Research in Science Education program for its support of this research study.

The interviews with women scientists, mathematicians, medical professionals, and engineers contributed enormously to this study. By sharing their personal experiences, observations, and insights with us, they helped us to understand the survey data and provided us with a much richer and more detailed appreciation of the influences that encourage women to pursue careers in scientific and technical fields, of the dynamics involved in educational and occupational decisionmaking, and of what it was and is like for them as students and professionals in these fields. We are grateful to them for their interest in our study, for their generosity with their time, and for their openness in discussing their personal experiences. In accordance with our promise of confidentiality, every effort has been made to present the data so that identification of individual responses is not possible. However, we would like to acknowledge the women whose assistance was so important to the success of this project: Jean Andrews, Madeline Justiniano Butler, Nitza Cintron-Trevino, Pauline Cisneros, Yvonne Clement-Cormier, Anamaris Colberg-Poley, Suzanne Craig, Jo Beth D'Agostino, Lydia David, Selma Goldstein, Marianne Hamm, Nancy Hayden, Margaret Jefferson, Y'Vonne Jones-Brown, Maria Lebrun-Luteyn, Maria Magana, Pat Manning, Nilda Martinez-Rivera, Deborra Mullins, Sandra Murray, Lynne Parenti, Rachel Perez, Alice Tolbert Plummer, Sylvia Ramos-Burch, Aida Sahagun, Leticia Valenzuela, Syvila Weatherford, Suzanne Heisler Weissman, Maria Elena Zavala, and Martha Zuniga. We wish them well.

Finally, we would like to thank our colleagues at the Higher Education Research Institute for their assistance: Margo R. King, the Institute's administrator; Barbara Kommel, who was responsible for the preparation of this manuscript; and Rebecca Highman, Lisa Rentschler, and John Somers for typing the interview transcripts, papers that were based on our research study, and draft chapters of this report.

The research discussed in this report was divided between the authors, with Rita Scherrei conducting the analyses of the survey research data and Patricia McNamara collecting and analyzing the interview data. Much as we appreciate the contributions acknowledged above, responsibility for the final product is ours.

Chapter One

Introduction to the Study

> . . . despite the rapid progress that has been made, women still remain the largest pool of talent available for increasing the size and quality of the science and engineering labor force. (National Science Foundation and Department of Education, 1980, p. 64.)

Women's representation among science and engineering degree-recipients at all levels increased quite remarkably over the past decade (Vetter, 1981). This evidence of women's growing interest in and training for scientific and technical careers has received widespread publicity. However, reports that the number of women scientists and engineers increased at nearly double the rate for men between 1974 and 1976 (NSF and Department of Education, 1980) can be misleading and foster premature complacency. We must not forget how seriously underrepresented women were in these fields and, thus, how many women will have to enter the scientific and engineering labor force before their representation even begins to approach equity. In 1979, women comprised 42 percent of the labor force, while accounting for only 3 percent of the nation's engineers, 5 percent of the dentists, 11 percent of the physicians, 16 percent of science and engineering technicians, 19 percent of all life and physical scientists including 15 percent of the chemists, and 26 percent of all computer specialists (U.S. Bureau of the Census, 1980). Women with doctorates in the sciences (including the social sciences and psychology) accounted for 10 percent of the nation's faculty at the rank of assistant professor and above in 1977, and for 5 percent of all federally employed scientists and engineers in 1978 (National Research Council, 1979 and 1980).

Certainly, improvements in women's status in the scientific and engineering labor force will be reflected in statistics on new and recent entrants long before we see evidence of substantial progress in these kinds of aggregate statistics. However, white, black, and Hispanic women continue to be seriously underrepresented among recipients of degrees in scientific and technical fields and their underrepresentation increases at each degree level from baccalaureate to doctorate (see Table 1). While these data clearly document women's underrepresentation compared against their representation in the population as a whole and even against their representation among degree recipients at each level, except among persons awarded medical degrees, the absolute numbers of black and Hispanic women earning doctorates is even more telling: In 1978-79, only 31 black and 17 Hispanic women were awarded doctorates in these five fields and over two-thirds were earned in the biological sciences. Our educational institutions must learn more about how to identify, encourage, and retain women with scientific and mathematical talent.

This research project examined the characteristics and persistence of young women who entered college during the seventies expressing an interest in science, math, and engineering. It specifically sought to identify those aspects of their educational experience that contributed to interest and success in these fields. This focus on the educational experience stemmed, first, from our belief that educators can and do influence young women's interest and achievements in science, math, and engineering and, second, from our desire to pursue research that would produce findings with practical implications for improving women's representation in the scientific and engineering labor force. It is clearly easier to manipulate curricular, environmental, sociological, and psychological aspects of the educational experience than it is

TABLE 1
Representation of Black, Hispanic, and White Women Among Recipients of Bachelor's, Master's, Doctor's, and First Professional Degrees in all Fields and in Selected Fields: 1978-79[a]

(in percentages)

Level and Field of Degree	Black	Hispanic	White
Bachelor's Degrees (N=911,637)	3.9	1.7	42.2
Biological sciences (N=48,674)	2.8	1.8	34.7
Computer and information science (N=8,392)	2.9	0.7	23.6
Engineering (N=58,003)	0.4	0.2	7.6
Mathematics (N=11,534)	2.9	1.2	36.5
Physical sciences (N=22,659)	1.2	0.6	20.3
Master's Degrees (N=281,811)	4.4	1.2	44.5
Biological sciences (N=6,415)	1.9	0.8	33.5
Computer and information science (N=2,528)	0.9	0.4	17.0
Engineering (N=11,417)	0.2	0.1	6.2
Mathematics (N=2,571)	1.4	0.6	34.7
Physical sciences (N=4,713)	0.4	0.3	17.2
Doctorates (N=28,774)	1.9	0.5	26.8
Biological sciences (N=3,205)	0.7	0.3	23.4
Computer and information science (N=188)	0.5	---	14.9
Engineering (N=1,635)	0.1	0.1	3.2
Mathematics (N=568)	0.2	0.2	16.2
Physical sciences (N=2,617)	0.2	0.2	9.9
First Professional Degrees (N=68,344)	1.5	0.6	20.9
Dentistry (N=5,437)	1.0	0.5	9.6
Medicine (N=14,837)	1.8	0.9	19.6

[a]Data presented in this table are based on preliminary tabulations provided by the National Center for Education Statistics (NCES) and exclude degrees awarded to nonresident aliens.

to alter any societal, familial, or socioeconomic conditions or influences that might be associated with young women's interest in science careers.

Design of the Study

The study design included: (1) a trends analysis of changes in the characteristics of the pool of science-oriented college freshmen from 1971 to 1979; (2) a longitudinal study of the educational and occupational choices of some 7,000 members of the freshman class of 1971 over an eight year-period, with particular attention to patterns of persistence in and recruitment into science fields; and (3) interviews with thirty professional women in scientific and technical fields that focused on critical influences on their career decisions. These women were approximately the same age as the members of the longitudinal sample. The common dependent variable in each phase of our study was success in the pursuit of a scientific, mathematical, or engineering goal. Our four success measures were based on intended or actual behavior rather than on any assessment of the quality or quantity of individual accomplishments and become progressively more restrictive in terms of who is classified as successful:

(1) planning at the time of college entry to pursue a major or career in science, mathematics, or engineering;

(2) earning a bachelor's degree in one of these fields;

(3) pursuing a graduate degree in one of these fields; and

(4) being employed in a scientific, engineering, or science-related professional field.

The independent variables of most interest were precollegiate educational experiences, although we also examined measures of self-concept and family background.

The trends analysis utilized the Cooperative Institutional Research Program's data bank which includes information on thousands of entering college

freshmen based on annual surveys. Changes in the educational backgrounds, career goals, and college choices of men and women who entered college aspiring to majors or careers in science and engineering were traced through the decade of the seventies. This analysis presents the data separately by sex for Blacks, Chicanos, Puerto Ricans, and Whites in order to identify differences between men and women and among the four groups of women.

While the size of the data base and the amount of information available for each student make the trends study comprehensive and generalizable to a greater degree than could be attained with most data bases, the study is limited by its reliance on secondary data. The freshmen surveys are designed for general trends measurement and to collect baseline data for possible follow-up studies, not for in-depth analysis of any major or occupational area. For example, it would have been desirable to have more objective academic information on students.

The longitudinal analysis also relied on existing data: survey data on freshmen who entered college in 1971 merged with their responses to a follow-up survey conducted in early 1980. This phase of the study focused specifically on women, although data on white males are presented to provide a basis for gauging women's success against that of the group that provides the "norm" for success in scientific and technical fields. The longitudinal analysis tracks this cohort through the scientific pipeline, from college entry into graduate school and the labor force. It also examines variables, especially high school variables, related to graduation from college with a degree in science, mathematics, or engineering.

The longitudinal analysis is limited by its reliance on data that were collected for other purposes and by the small numbers of minority respondents,

especially minority women with an interest in the sciences. Because the undergraduate and graduate fields were coded into broad categories, we could not conduct separate analyses for the physical sciences and mathematics. Despite its limitations, this data base does provide invaluable information on a national sample covering a period of over eight years.

The interviews were intended to "flesh out" the statistical profiles generated by the survey research data and to provide further information about high school, college, and graduate or professional school facilitators of and barriers to careers in scientific and technical fields. The fourteen interviews with Chicano and Puerto Rican women were especially helpful, compensating to some extent for the very small numbers of women from these groups in the longitudinal analysis. Although we cannot generalize from the experiences of thirty women, these interviews complement and are very useful in understanding the trends data and the findings of the longitudinal analysis.

When they are combined, the data from these three phases of the study provide a unique package of information about women's scientific aspirations and accomplishments. There are data comparing men and women, women from four different racial-ethnic groups, and women in the biological sciences, the physical sciences and mathematics, and engineering. We examine trends over time, predictors of scientific success during the undergraduate years, and the progress of one cohort of college freshmen through the scientific pipeline over an eight-and-a-half year period. Finally, we take an in-depth look at the family backgrounds, the educational experiences, and the career progress of thirty young women who pursued much of their training for scientific and technical careers during the seventies.

Major Findings

The findings of the study are presented and discussed in detail in the chapters that follow, but highlights are summarized below: The trends analysis shows that:

- Despite small gains, women continued to be underrepresented among college freshmen expressing interest in science fields throughout the seventies. The field that showed the greatest increase in popularity among women was engineering.
- Minority women are not only underrepresented among college freshmen planning to pursue degrees and careers in science and engineering, minority students who do indicate an interest in these fields enter college with poorer academic preparation than their white peers.
- By the end of the decade, the goals and aspirations of science-oriented minority women were as high and, in come cases, higher than those of science-oriented white women despite their generally poorer academic backgrounds.
- Over the seventies, we see a shift in the career aspirations of science-oriented freshmen women away from such traditionally female fields as teaching, nursing, and the allied health professions and toward engineering and the medical professions.

The longitudinal analysis shows that:

- High school mathematics preparation is critical to successful completion of an undergraduate degree in the sciences, mathematics, and engineering. Variables reflecting the strength of precollegiate mathematics training accounted for more variance between students who achieved this outcome measure and their peers who majored in nonscience fields than any other variables in the study.
- Parental education, occupation, and other measures of students' socioeconomic background are not highly significant predictors of successful completion of an undergraduate degree in scientific and technical fields when college graduates are studied. Apparently these background factors which are so important to access and persistence in college are not especially influential determinants of major field choices.
- Most of the students who earn undergraduate degrees and who pursue graduate degrees in the sciences, mathematics, and engineering enter college planning to major in these or other science fields. The drift into these fields from nonscience fields is small in comparison with the drift out of the sciences.
- When the science persistence rates of white, black, and Hispanic women are compared with those of white men, we find that women, especially

minority women, who enter college planning to major in the sciences or math are less likely than white men to graduate with a degree in these fields or in any science-related field.

- White women who do earn undergraduate degrees in the sciences and math go on to pursue advanced degrees at rates substantially lower than those of their black female and white male peers. Students who earn degrees in the biological sciences are more likely to pursue advanced degrees in science-related fields than are physical science and math majors. Similarly, a higher proportion of male than female science and math majors who go on for advanced degrees remain in scientific and technical fields.

- Students who earn bachelor's degrees in engineering are most likely to hold jobs related to their undergraduate field of study, followed by biology majors and then physical science and math majors.

Analysis of the interview data suggests that:

- Parental emphasis on educational attainment and encouragement of or, at least, neutrality toward their daughter's interest in science, math, or engineering are far more important to science achievement than parental education, occupation, or income.

- Interest in science and math develops early and is reinforced by academic success in these subjects and by teachers who are remembered as outstanding members of their profession. These women entered college with strong preparation in science and math and few entertained the idea of majoring in a nonscience field.

- High school counselors, at best, provided information about how to apply to college; their efforts to provide career guidance were ineffective. Almost half of the minority women who attended high school in the states reported that counselors had discouraged their educational and career aspirations, the usual explanation given being that the counselor perceived their aspirations as unrealistically high.

- Our respondents emphasized the importance of a strong high school background in science and, especially, math to subsequent success in scientific and technical fields. They are convinced that many young women foreclose their career options before they even enter college by avoiding these courses in high school.

- The individuals most frequently cited as role models were teachers, college instructors, and older students--usually women. However, the interviews suggest that there is no more powerful source of discouragement than a negative experience working with a woman in one's field. Young woman need confirmation that pursuing a scientific or technical career will not necessitate sacrificing other interests, including their prospects for marriage and having a family.

- Hands-on research experience is critical to the development of scientific interests, of skills that are essential to success, and of self-

confidence in one's abilities. Since such experience also tends to confirm or disconfirm one's interest in a research career, the earlier students become involved in research the better.

- At the undergraduate level, financial considerations and parental constraints on geographic mobility play a more important role in the college choice process than does quality of an institution's science program. At the graduate level, reputation of the institution, the specific department, or of individual professors are more important than cost or location in deciding where to continue one's education.

- Almost all of our respondents relied on financial aid to help them meet their undergraduate educational expenses, and a number of the Chicanas and black women received no financial help from their families. Many of these women quite simply could not have pursued advanced degrees without substantial financial aid support.

- Our respondents did not encounter bias against women in scientific and technical fields until they began pursuing graduate or professional degrees. In fact, the support and encouragement of their undergraduate professors was often critical to their decision to pursue advanced degrees.

- Few of these women entered college with long-range educational or career plans and most began to consider attending graduate or professional school during their junior or senior year. When women decided to go to graduate school, they almost invariably saw college teaching as their future occupation. Their career interests diversified during graduate school as they learned about other professional options, discovered whether they enjoyed teaching, and watched postdocs and young faculty members struggle to gain a foothold in the academic labor market.

In sum, our research results indicate that interest in science and math develops early and that elementary and secondary schools play a critical role in reinforcing this interest and in providing the skills that are a prerequisite for subsequent success. Women college freshmen are less likely than their male peers to express an interest in pursuing science-related majors and careers and this appears, at least in part, to be due to women's poorer preparation and lower self-confidence in science and math. Even among those students who do express an interest in science and math, women appear less confident than men and are more likely to switch to nonscience majors. Women who succeed in earning undergraduate degrees in the sciences, math, and engineering appear to

be exceptionally good students with strong high school preparation in science and math. The support and encouragement of high school teachers and college faculty appear to be important to women's persistence and achievement in scientific and technical fields.

Chapter Two

The Trends Analysis

The purpose of this chapter is to describe the changes that occurred during the seventies in the composition and characteristics of the pool of freshmen who entered college expressing an interest in science-related majors or careers. The analysis examines not only the proportional representation of women and minorities but also changes over time in the high school background, parental education, degree and career aspirations, and type of college chosen by these science-oriented students.

We used data from the Cooperative Institutional Research Program (CIRP) annual surveys of several hundred thousand freshmen entering colleges and universities across the nation for the trend analysis. This data base includes information on each respondent's sex, intended college major, degree and career goals, as well as over 200 other personal, educational, and affective variables.* We examined trends in major field and career aspirations over a nine-year period, 1971 to 1979, using data from every other year.

Table 2, which summarizes the total representation of students by race-ethnicity and sex for the data bases analysed, illustrates several general trends that are important to establish the context for the more specific analysis of women in science, mathematics, and engineering. First, the relative number of women entering college increased by 6.6 percent during the seventies: from 45.6 percent of the freshman class of 1971 to 52.2 percent of the entering class of 1979. Second, minority participation showed a similar though smaller increase over this period, from 8.6 percent to 12.8 percent of all freshmen. Thirdly, the representation of black women is consistently greater than that of black men, and this differential has increased over time.

*Details on the annual studies can be found in The American Freshman: National Norms for Fall 1971 through 1979 (see references).

TABLE 2

Distribution of Cooperative Institutional Research Program Participants by Race/Ethnicity and Sex: 1971, 1973, 1975, 1977 and 1979

(in percentages)

Year of Survey	Number of Participants	White		Black		Chicano		Puerto Rican	
		Male	Female	Male	Female	Male	Female	Male	Female
1971	171,509	50.1	41.3	3.0	3.3	0.6	0.5	0.1	0.1
1973	189,733	47.1	41.5	3.7	4.1	0.7	0.6	0.3	0.2
1975	186,406	46.4	40.1	4.3	4.7	1.0	0.7	0.4	0.3
1977	198,641	44.6	42.4	4.0	4.8	0.7	0.7	0.5	0.5
1979	190,151	42.6	44.6	4.0	5.3	0.5	0.6	0.5	0.5

Note: The rows do not add to 100% since Native and Asian Americans are not included in the table. To aid in interpretation it should be noted that total male participation was 54.4% in 1971, 52.8% in 1973, 53.2% in 1975, 50.7% in 1977, and 48.4% in 1979.

In order to examine our first "success" variable, aspiration to a major or career in science or engineering at the time of college entry, subgroups were selected from each annual sample on the basis of anticipated major or anticipated career. The major fields of interest included the biological sciences, engineering, physical sciences, mathematics and computer science; the careers of interest were engineer, research scientists, computer programmer or analyst, and statistician. (A representative questionnaire can be found in Appendix A.) Subfiles were generated for each of the five years by selecting all students who indicated a major and/or career preference in one of these areas. The composition of these subfiles by race-ethnicity and sex are shown in Table 5.

Clearly, there is some progress over time: Women's participation in scientific fields increases from 25.2 percent to 30.3 percent over this nine-year period. However, this 5.1 percent increase is even smaller than the 6.6 percent increase in women's representation among college freshmen over these same years. Thus, our data suggest that very little actual change in the direction of women choosing science has occurred over the past decade.

Is the "double bind" theory applicable in science and engineering--that is, does being minority and being female create double disadvantages that must be overcome to enter and succeed in these fields? Our data suggest that once college is attained, being female is a far better predictor of non-science choices than is being minority. Relative to their representation in college, minority men are not underrepresented in the sciences. Chicano and Puerto Rican women are more underrepresented than white women who are, in turn, more underrepresented than black women. Nonetheless, compared with black men whom they outnumber, black women are underrepresented among freshmen aspiring to scientific majors and careers.

TABLE 3

The Trends Data Base: College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex: 1971, 1973, 1975, 1977 and 1979

(in percentages)

	1971 (N=60,250)	1973 (N=63,140)	1975 (N=63,831)	1977 (N=58,392)	1979 (N=62,486)
Whites					
Males	69.7	68.6	65.5	62.0	62.8
Females	23.0	23.0	24.9	28.2	25.9
Blacks					
Males	4.2	4.5	4.8	4.7	5.7
Females	2.0	2.5	3.1	3.5	4.0
Chicanos					
Males	0.7	0.6	0.7	0.6	0.6
Females	0.2	0.2	0.3	0.3	0.2
Puerto Rican					
Males	0.3	0.4	0.5	0.5	0.6
Females	0.1	0.2	0.2	0.2	0.2
Total					
Males	74.8	74.1	72.6	67.7	69.7
Females	25.2	25.9	27.4	32.3	30.3

Academic Background

Although women are underrepresented among science-oriented freshmen, those women who do indicate an interest in science-related majors or careers appear to be high achievers. Using average high school grade as a measure of academic achievement, we find that science-oriented freshman women are not only more likely than all freshmen and all women to report that they were "A" students in high school, they are more likely to have earned an "A" average than their science-oriented male peers (see Table 4). Although we find this pattern across all four racial-ethnic groups, a far greater proportion of Whites than of any of the other three groups enter college with an "A" high school grade average.

The data presented in Table 4 also provide strong evidence of grade inflation over the seventies. For example, only 10.2 percent of white men reported an "A" average in 1971, compared with 18.6 percent in 1979. This same pattern is seen among all four groups, with occasional exceptions (Chicano men in 1975, for example). The greater variablity in the grades reported by Puerto Rican women is probably due to the very small size of this sample.

These data suggest that high achievers are over-represented in the sciences; that women are higher achievers than men of the same racial-ethnic background; and that white students in the sciences enter college with higher grades than any of the other groups being studied. Finally, although the proportions of science-minded students with "A" averages have increased over the years, this increase reflects an overall pattern of grade inflation.

Other measures reflecting the quality of high school academic preparation show far smaller differences between the sexes but confirm our impression that Whites going into the sciences are better prepared than minority students.

TABLE 4

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting High School "A" Averages

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	10.2	15.2	17.8	17.9	18.6
Females	18.6	26.0	28.7	27.6	30.0
Blacks					
Males	2.5	5.0	4.5	5.6	5.8
Females	5.9	10.9	9.2	10.9	10.2
Chicanos					
Males	6.4	10.2	20.0	10.8	18.1
Females	6.2	14.2	18.9	19.9	21.9
Puerto Rican					
Males	5.9	11.4	9.1	10.5	14.8
Females	16.2	24.7	16.7	20.4	15.1
All Freshmen	5.7	7.5	8.0	8.6	9.2

Although most science-oriented students participated in college preparatory programs during high school, as Table 5 shows, a greater proportion of white women than of any other group reported enrollment in such programs.

In 1975 and 1977, the freshman questionnaire asked students to indicate how well their high school had prepared them for college in mathematics and science. As Table 6 shows, white women feel somewhat less well prepared in mathematics than white men, but far better prepared than any of the male or female minority students. Although black men and women report feeling well prepared in mathematics in about equal proportions, both groups of Hispanic men feel considerably better prepared than their female counterparts and than black students. An almost identical pattern emerges from the data on science preparation for Whites and Blacks. However, the differences between Hispanic men and women are negligible in 1975, and actually favor females in 1977.

Table 7 shows the proportions of freshmen from each group who anticipate needing remedial or special help in mathematics and science. Since the question was phrased somewhat differently in each questionnaire, the results can not really be compared except to note that white women anticipated less need for special assistance in math or science in 1979 than any other group, male or female. Black freshmen were most likely to anticipate needing special math assistance in both years and help in science in 1977.

While no real academic trends--other than grade inflation-are obvious, these data do suggest that white women entering science are the best prepared as measured by grades and participation in a college prep high school program; white men are the best prepared in mathematics and science as measured by their self-evaluations; and Whites are better prepared than minority students. Minority women in science are slightly better prepared than minority men, as assessed on the basis of grades and type of high school program, but the

TABLE 5

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting Participation in a High School College Preparatory Program[a]

(in percentages)

	1975	1977	1979
Whites			
Males	95.3	94.9	94.6
Females	96.7	96.1	95.7
Blacks			
Males	80.7	82.2	85.5
Females	86.0	84.2	81.8
Chicanos			
Males	91.2	85.8	92.8
Females	92.9	89.7	88.7
Puerto Rican			
Males	83.0	81.0	80.2
Females	90.1	84.3	80.3

[a]This information was not collected in 1971 or 1973.

TABLE 6

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting They Were Very Well Prepared in Mathematics and Science in High School

(in percentages)

	Mathematics		Science	
	1975	1977	1975	1977
Whites				
Males	53.7	52.7	55.8	54.7
Females	50.0	47.6	52.9	50.6
Blacks				
Males	34.9	36.4	42.0	39.8
Females	37.0	36.2	44.5	40.7
Chicanos				
Males	45.9	45.3	39.6	38.4
Females	35.5	39.7	37.9	42.9
Puerto Rican				
Males	41.9	43.9	48.3	40.8
Females	34.3	34.3	48.0	49.5

TABLE 7

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Anticipating a Need for Remedial or Special Help in Mathematics and Science[a]

(in percentages)

	Mathematics		Science	
	1977	1979	1977	1979
Whites				
Males	12.4	5.8	4.5	3.8
Females	18.2	3.8	8.1	2.3
Blacks				
Males	38.7	13.1	20.6	11.2
Females	46.7	11.9	28.4	9.1
Chicanos				
Males	27.4	8.8	17.8	9.1
Females	35.8	5.3	22.6	6.6
Puerto Rican				
Males	37.1	10.3	16.2	12.3
Females	33.6	9.2	14.5	17.0

[a]This question was only asked in 1977 & 1979.

results are mixed for math and science preparation. Blacks and Puerto Ricans appear to have received the poorest high school preparation. Just as sex is the better predictor of choice of science or engineering, race-ethnicity is the better predictor of quality of precollegiate academic preparation. Clearly, and this is true for all years we examined, being Black, Mexican-American or Puerto Rican predicts having received poorer academic preparation for a college science major than does being white.

Parental Education

Parental education is one measure of the socioeconomic status of a student's family. As Tables 8 and 9 show, science-oriented white women have the best educated parents of any of the eight student groups. For all groups, there is an increase over time in mothers' and fathers' educational attainment, but minorities, regardless of gender, have less well educated parents than white freshmen. White students' fathers were more likely to be college graduates in 1971 than were the fathers of any of the minority student groups in 1979. Similarly, white women's mothers were more likely to be college graduates in 1971 than any group in 1979 except for white men. It is interesting to note that Chicano students have the least well educated mothers. Blacks are the only group whose mothers appear to be at least as well educated as their fathers.

Now the question of the "double bind" has a clearer answer. Being female predicts <u>not choosing</u> science; being minority predicts entering the sciences at the college level with poorer academic preparation and a less advantaged socioeconomic background (as reflected in parental education). Being female <u>and</u> minority does appear to be a double handicap to success in science, mathematics, and engineering.

TABLE 8

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting their Fathers are At Least College Graduates

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	33.1	41.7	45.9	45.8	47.6
Females	40.6	48.0	51.8	52.0	51.4
Blacks					
Males	14.1	17.0	18.0	21.7	23.4
Females	15.5	18.2	19.9	20.8	18.9
Chicanos					
Males	9.4	13.3	20.1	16.1	23.2
Females	10.6	18.8	22.3	22.4	27.1
Puerto Rican					
Males	13.3	36.8	22.9	28.3	29.7
Females	18.9	23.3	30.4	24.9	32.5

TABLE 9

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting their Mothers are At Least College Graduates

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	20.7	25.2	29.3	28.6	29.9
Females	27.0	31.0	32.9	34.0	34.6
Blacks					
Males	15.6	16.6	19.6	21.8	25.7
Females	16.2	18.8	21.4	21.7	21.9
Chicanos					
Males	3.8	7.8	11.4	7.9	14.3
Females	3.2	9.2	13.6	11.7	12.6
Puerto Rican					
Males	13.5	16.1	17.5	20.1	21.8
Females	16.2	19.5	27.9	24.3	23.4

Degree and Career Aspirations

Do young men and women from these four groups differ in their educational and occupational aspirations? Table 10 shows the proportions of each group who, at the time of college entry, reported that the highest degree they hoped to attain was a bachelor's, a master's or doctorate, or a medical degree. The vast majority of science-oriented freshmen enter college planning to complete at least a bachelor's degree: In 1971, over four-fifths of every group except the Chicano students planned to earn a bachelor's or higher degree and, in 1979, 95 percent of White, Chicano, and Puerto Rican men and white women planned to earn at least a baccalaureate, as did 93 percent of black men, 92 percent of black women, 90 percent of Chicanas, and 89 percent of Puerto Ricanas. The student group whose aspirations show the largest increases over time are the Chicanos and, interestingly, this upward shift in their degree aspirations occurs in the early seventies, between 1971 and 1973.

Over the years, degree aspirations have risen. A larger percentage of all science-oriented freshmen, especially women, entered college hoping to pursue graduate or medical degrees in the late seventies than in the early seventies. A slight reversal in this trend can be seen in the late seventies, especially among white men and women. Similarly, there is a rather dramatic increase in the popularity of medical degrees during the early seventies that peaks in 1973 or 1975, depending on the student population, and then declines in the late seventies. Nonetheless, except for white men, a larger proportion of each group aspired to medical degrees in 1979 than in 1971.

Perhaps the most interesting pattern reflected in these data is the similarities across groups. Although women tend to express a somewhat stronger interest in obtaining medical degrees and a somewhat lower interest in graduate

TABLE 10

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Degree Aspirations: Bachelor's and Above

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males					
Bachelors	30.2	18.4	23.3	27.0	28.2
Graduate	47.9	52.8	50.5	56.2	56.6
Medical	11.0	23.4	20.7	12.0	10.2
Females					
Bachelors	39.3	20.1	22.6	26.5	27.5
Graduate	41.6	46.6	44.4	52.0	51.6
Medical	9.2	28.2	28.0	15.7	16.0
Blacks					
Males					
Bachelors	24.8	15.1	21.0	19.6	20.2
Graduate	54.7	58.2	52.1	60.5	60.0
Medical	9.0	19.4	16.8	12.0	12.5
Females					
Bachelors	24.4	9.5	15.7	13.9	16.8
Graduate	52.5	51.2	44.8	58.3	58.3
Medical	12.4	34.5	31.6	19.3	17.1
Chicanos					
Males					
Bachelors	35.0	14.0	18.0	24.1	23.6
Graduate	35.8	50.2	48.4	52.1	58.5
Medical	5.6	25.6	26.4	14.1	12.7
Females					
Bachelors	29.9	15.0	15.5	20.1	12.4
Graduate	36.1	38.0	43.8	51.9	51.1
Medical	4.1	37.0	33.2	21.3	26.3
Puerto Rican					
Males					
Bachelors	32.0	19.7	23.1	23.6	16.1
Graduate	43.8	47.8	49.2	55.0	63.7
Medical	10.5	26.5	20.8	15.5	15.0
Females					
Bachelors	36.1	9.1	9.8	18.8	16.8
Graduate	30.6	48.1	48.8	46.9	51.3
Medical	19.4	37.7	32.9	29.2	20.4

degrees than their male peers, all students have high degree aspirations. Despite differences in high school preparation and parental education, white and minority freshmen who express an interest in science fields, whether they are male or female, enter college hoping to achieve highly similar educational objectives.

One of the items that appears on the freshman survey asks students to indicate the personal importance of realizing a series of "life goals". Two of these life goals--"Making a theoretical contribution to science" and "Becoming an authority in my field"--seemed particularly germane to our assessment of science-oriented students' aspirations. As Table 11 shows, the importance students ascribed to making a theoretical contribution to science increased substantially during the early seventies but shows little subsequent change. Furthermore, minority students consistently attach greater importance to achieving this goal than their same-sex white peers, although black and white women are nearly the same in their valuing of this goal. The differences between men and women are relatively small although, within each racial-ethnic group, we find that men tend to rate this goal as very important more often than women. This pattern is consistent with women's greater expressed interest in becoming doctors, professionals who apply their scientific training in medical practice, and men's greater interest in graduate training which places more emphasis on research.

Becoming an authority in one's field is an ambition that reflects a desire to become engaged in independent thinking and scientific advancement that is most common among scientists and engineers active in teaching and research. Certainly, it also reflects a desire to master knowledge and skills that are needed to excel in one's field and to gain the respect of one's colleagues. As

TABLE 11

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Who Rate Making a Theoretical Contribution to Science as a Very Important Life Goal[a]

(in percentages)

	1971	1975	1977	1979
Whites				
Males	25.9	33.8	35.9	33.7
Females	20.9	32.9	32.7	34.0
Blacks				
Males	25.7	37.5	36.7	38.3
Females	22.5	37.5	32.5	32.2
Chicanos				
Males	21.9	43.5	40.9	37.9
Females	25.0	33.8	36.2	42.1
Puerto Rican				
Males	32.3	41.4	42.6	41.6
Females	22.2	47.5	37.7	36.7

[a]This question was not asked in 1973.

Table 12 shows, the importance students attached to becoming an authority in their field increased during the seventies, peaking in 1977 for some groups and continuing to show gains in 1979 for others. Again, we find that minority students tend to attach greater importance to achieving this goal than white students, and that men are somewhat more likely than their female peers to place a high value on this goal.

The most striking trends data are those showing changes over time in students' career aspirations. As Table 13 shows, interest in pursuing an engineering career increased among all student groups during the seventies, most dramatically among women. In 1971, 4 percent of black women, 2 percent of white women, and none of the Chicano and Puerto Rican women who expressed an interest in science wanted to become engineers; the comparable figures for 1979 are 23 percent, 18 percent, 17 percent, and 13 percent. In contrast, men's interest in engineering careers shows only about a 1.5 fold increase over this same period. In 1971, nearly fifteen times as many men as women--proportionally--were interested in engineering careers; by 1979, the differences had shrunk to about 2.5 times more men than women.

Next to engineering, scientific research was the most popular career goal among science-minded freshmen. However, the popularity of this career has declined over time (see Table 14). Interest in careers in scientific research peaked in 1973, and continued to decrease in subsequent years. It is interesting to speculate about what has led to this marked loss of interest in research. Has the well-publicized demand for engineers encouraged scientifically talented students to go into engineering? Are high school students receiving less exposure to research and less information about research careers and, thus, not considering this career option? Or is scientific research less appealing as the result of some shift in societal values and attitudes? Whatever the explanation,

TABLE 12

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Who Rate Becoming an Authority in Their Field as a Very Important Life Goal

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	22.1	26.8	32.1	36.8	32.4
Females	18.4	23.6	28.0	33.0	29.2
Blacks					
Males	31.9	37.6	41.7	43.1	43.5
Females	29.2	32.4	37.6	43.7	40.0
Chicanos					
Males	24.4	32.9	39.5	39.3	39.5
Females	22.9	18.4	28.1	32.8	33.3
Puerto Rican					
Males	33.6	24.2	37.2	39.9	35.3
Females	27.8	19.8	36.3	37.0	36.6

TABLE 13

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Engineer

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	30.3	29.6	32.9	47.7	47.1
Females	2.2	4.5	9.7	14.0	18.3
Blacks					
Males	28.5	32.7	33.9	47.4	47.4
Females	3.6	4.3	9.6	16.3	23.2
Chicanos					
Males	28.3	27.0	27.2	49.6	43.0
Females	--	3.3	8.8	19.5	16.6
Puerto Rican					
Males	40.3	38.4	35.0	55.1	41.1
Females	--	6.3	7.5	10.9	12.8

TABLE 14

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Scientific Researcher

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	12.8	15.4	10.2	12.1	8.7
Females	16.7	25.1	15.6	17.2	15.0
Blacks					
Males	7.3	10.8	5.9	5.2	3.3
Females	10.5	18.0	6.5	5.8	3.9
Chicanos					
Males	6.4	11.0	7.7	5.8	6.9
Females	12.2	17.5	8.8	8.9	9.9
Puerto Rican					
Males	7.5	8.8	7.7	5.1	4.0
Females	21.6	20.0	7.5	10.0	4.3

white women have consistently indicated the greatest interest in this type of career and seem to be less disaffected than any other group of women. Although minority women, like white women, indicate a somewhat higher level of interest in research careers than their male peers, the proportion of minority women interested in scientific research decreased substantially between 1973 and 1979.

Medical careers as doctors, dentists, and veterinarians became more attractive to women and Hispanic men during the seventies (see Table 15). Although medical careers were not as popular among freshmen in the late-seventies as they were in the mid-seventies, the only groups expressing less interest in these careers in 1979 than in 1971 are white and black men. Medicine and engineering combined account for the career goals of 28 percent of the science-oriented white and Puerto Rican women, 38 percent of the black women, and 40 percent of the Chicanas who entered college in 1979.

The health professions, which include all health-related careers except medicine and nursing, are more attractive to women than to their male peers (see Table 16). Over time, the health professions have become less popular with women, although they show a sudden increase in popularity among Puerto Rican women in 1979. Minority men, particularly Chicanos, indicate a greater interest in the health professions than do white men.

Since 1971, business careers have become less popular across all groups of science-minded students. As Table 17 shows, the most dramatic decline in their popularity occurred in the early seventies with a relatively stable popularity from then on. Differences between men and women and across racial-ethnic groups are small, although business careers are least appealing to Puerto Rican students.

Like the health professions, secondary school teaching has become a less attractive career goal for women during the seventies (see Table 18). While

TABLE 15

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Physician, Dentist or Veterinarian

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	10.1	19.1	16.5	9.3	7.7
Females	6.4	19.0	18.0	10.0	10.5
Blacks					
Males	9.3	16.2	13.5	9.5	8.8
Females	10.6	29.2	26.4	16.6	14.9
Chicanos					
Males	6.7	22.5	25.3	12.6	12.1
Females	4.1	30.8	31.6	20.0	23.2
Puerto Rican					
Males	10.7	19.7	16.6	9.6	12.6
Females	18.9	29.5	27.4	26.4	14.9

TABLE 16

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Health Professional

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	2.9	3.4	3.1	2.5	1.9
Females	11.1	12.5	11.2	9.3	8.0
Blacks					
Males	2.0	2.7	2.9	2.3	2.1
Females	7.5	6.8	7.4	6.2	4.3
Chicanos					
Males	1.5	2.5	2.3	3.6	3.9
Females	8.2	7.5	10.2	6.8	7.3
Puerto Rican					
Males	2.5	2.8	3.9	3.7	2.3
Females	8.1	6.3	12.3	6.4	11.3

TABLE 17

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Businessperson

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	5.6	1.5	1.2	1.3	2.3
Females	2.2	1.0	0.7	1.7	1.7
Blacks					
Males	8.6	1.2	1.2	1.3	1.3
Females	5.1	1.7	0.9	1.4	1.5
Chicanos					
Males	6.4	1.4	0.6	1.1	1.7
Females	6.1	2.5	0.9	0.5	2.0
Puerto Rican					
Males	3.1	1.1	1.2	0.7	0.9
Females	2.7	1.1	--	--	--

TABLE 18

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Secondary School Teacher

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	3.3	1.5	0.6	0.6	0.4
Females	9.4	3.7	2.0	1.4	1.1
Blacks					
Males	3.7	0.8	0.5	0.6	0.2
Females	6.2	1.8	1.1	0.7	0.5
Chicanos					
Males	3.2	1.4	1.3	1.6	0.6
Females	5.1	1.7	1.9	1.6	0.7
Puerto Rican					
Males	0.6	0.4	0.3	0.4	--
Females	10.8	4.2	1.9	1.8	--

women were far more likely than men to indicate an interest in high school teaching in the early seventies, this difference has virtually disappeared over time. Men were also less likely to indicate an interest in teaching in the late seventies than in the early seventies. Looking at these data, one can not help wondering where high schools will find science teachers in the coming years. As Table 19 shows, college teaching has also declined in its popularity as a career goal. This profession is probably not especially attractive to entering college freshmen simply because of their lack of familiarity with it. However, the extreme drop in interest in high school teaching is in an area where freshmen do have personal and recent experience.

The final career goal we looked at was nursing. Since students planning to major in nursing or to pursue a nursing career were not selected for inclusion in our subfiles of science-minded students, those students in the subfiles who aspire to nursing careers obviously represent a very small proportion of college freshmen interested in becoming nurses. Nursing has never appealed to science-oriented males, as Table 20 clearly documents, and its popularity with science-oriented freshman women has declined steadily over the seventies.

Can some general observations be made about the career choice trends of science students, especially women? First, engineering is growing in popularity: in 1979 it accounted for the career goals of over 40 percent of all men in science and engineering and close to 20 percent of all women whereas in 1971, it attracted 30 percent of the males and only about 2.5 percent of the women. Since the absolute size of the pool has not really changed substantially, this represents a significant shift. On the other hand, we see loss of interest in scientific research in all groups except white women and Mexican-American men;

TABLE 19

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: College Teacher

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	0.7	0.7	0.5	0.4	0.3
Females	0.8	0.7	0.4	0.3	0.2
Blacks					
Males	0.8	0.7	0.3	0.2	0.1
Females	1.3	1.1	0.5	0.4	0.4
Chicanos					
Males	0.7	--	0.4	0.8	0.3
Females	1.0	1.7	1.9	0.5	0.7
Puerto Rican					
Males	0.6	0.7	--	0.4	--
Females	--	--	--	--	--

TABLE 20

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students' Career Goal: Nurse

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	--	--	--	--	--
Females	5.0	1.6	1.3	1.1	0.8
Blacks					
Males	0.2	--	--	--	--
Females	5.7	3.7	3.3	2.2	1.2
Chicanos					
Males	0.2	--	--	--	--
Females	5.1	0.8	1.9	0.5	1.3
Puerto Rican					
Males	--	--	--	--	--
Females	10.8	2.1	1.9	1.8	2.1

we see great declines in the attractiveness of teaching, especially among women; and there are some declines in the appeal of the health professions. Medicine has become much more attractive to women and somewhat less attractive to men. Certainly, our data indicate that women's interest in the traditionally male fields of engineering, medicine, dentistry, and veterinary medicine has increased over the past decade, while their interest in the traditionally female fields--high school teaching, nursing, and the health professions--has declined.

College Choice

Finally, we looked at several aspects of the college choice behavior of these science-oriented students. We were specifically interested in determining whether there had been any changes over time in the importance these students gave to academic reputation in selecting a college and in the type of higher education institution they chose. Our data show that women are more likely than their male peers to report that academic reputation was a very important reason for their college choice (see Table 21). All groups report a considerable increase in the importance of academic reputation in the early seventies which may be directly related to the dramatic increases in financial aid at that time. Since 1975, the proportions of students in each group who report that reputation played a key role in their choice process has stabilized or declined slightly. The fact that science-minded women choose colleges for academic reasons more often than their male peers flows logically from their stronger academic performance and their greater participation in college preparatory programs. Whites and Chicanos appear to place somewhat more importance on academic reputation than do Blacks and Puerto Ricans.

TABLE 21

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Reporting Academic Reputation was a Very Important Reason for Their College Choice

(in percentages)

	1971	1973	1975	1977	1979
Whites					
Males	44.7	62.6	63.6	61.8	62.1
Females	45.0	68.2	69.1	67.6	67.8
Blacks					
Males	41.0	58.2	58.4	57.1	58.6
Females	41.7	67.1	66.4	65.1	63.0
Chicanos					
Males	32.0	57.4	70.5	61.0	65.7
Females	41.5	76.5	72.2	67.4	67.6
Puerto Rican					
Males	41.4	59.4	62.4	51.3	53.1
Females	36.1	69.2	59.8	65.4	61.8

Because universities are, on average, larger than four-year colleges and two year colleges and because they offer graduate programs, they are more likely to offer an extensive selection of science courses, to have more and better-equipped laboratory facilities, and to provide students with opportunities to become involved in faculty research. Thus, in general, we feel university attendance is most desirable for science-bound students. (There are obvious exceptions to this generalization, selective four-year colleges being one example.) On the other hand, we believe that two-year colleges are the least desirable colleges for these students. Research (Astin, 1975 & 1977) has shown that students' chances of obtaining a bachelor's degree are considerably lowered by enrollment in a community college.

Tables 22 and 23 show that minority students' access to or choice of universities increased during the past decade, peaking in 1975, while white students were enrolling in universities at about the same rate throughout these years. Women appear to have made somewhat greater progress than men in gaining access to universities. Smaller proportions of white and Puerto Rican freshmen were entering two-year colleges in 1977 than in 1971, although there are indications of a slight reversal in this trend. Although Chicanos were more likely to enter two-year colleges than any other student group, their representation in these institutions did decrease over time. Women are less likely to attend two-year colleges than are men, a finding which is consistent with the greater importance they give to academic reputation in choosing a college.

As Table 24 shows, women are more likely than men to attend private colleges and universities. We find that this holds true for all four years for which data are available and transcends racial-ethnic differences. Although choice of a private institution rose across all groups over time, minorities

TABLE 22

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Attending Universities as College Freshmen[a]

(in percentages)

	1971	1973	1975	1977
Whites				
Males	44.8	47.0	47.1	45.5
Females	43.0	45.0	47.5	43.2
Blacks				
Males	22.7	17.7	23.5	27.1
Females	26.3	23.7	29.5	33.5
Chicanos				
Males	30.3	35.5	48.7	43.8
Females	34.7	45.8	46.5	40.5
Puerto Rican				
Males	23.9	37.7	25.2	32.4
Females	21.6	38.9	42.6	40.9

[a]Data were not available for 1979.

TABLE 23

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Attending Two-Year Colleges as Freshmen[a]

(in percentages)

	1971	1973	1975	1977
Whites				
Males	16.8	9.5	10.0	12.9
Females	12.5	7.9	7.8	9.5
Blacks				
Males	16.3	19.0	18.3	13.1
Females	11.3	12.7	13.2	11.5
Chicanos				
Males	57.9	32.1	15.5	19.5
Females	37.8	20.8	14.9	17.9
Puerto Rican				
Males	18.2	12.3	13.9	14.0
Females	18.9	11.6	7.5	8.2

[a]Data were not available for 1979.

TABLE 24

Trends in Characteristics of College Freshmen Aspiring to Careers and/or Majors in Science, Mathematics and Engineering by Race/Ethnicity and Sex

Students Attending Private Institutions as Freshmen[a]

(in percentages)

	1971	1973	1975	1977
Whites				
Males	35.5	41.8	41.0	39.9
Females	42.2	48.6	48.0	48.2
Blacks				
Males	36.2	35.6	35.8	38.1
Females	40.7	48.3	43.7	46.8
Chicanos				
Males	16.7	34.6	44.3	36.4
Females	33.7	50.8	54.9	49.5
Puerto Rican				
Males	46.5	40.5	38.5	40.8
Females	37.8	51.6	64.2	57.3

[a]Data were not available for 1979.

and particularly Chicanos have made the greatest progress in this regard. By 1977, science-minded minority students were attending private institutions in approximately the same proportions as their same-sex white peers. In fact, Puerto Rican women were considerably more likely to choose private colleges than any other group of women in 1975 and 1977.

Conclusion

Women continue to be underrepresented in the pool of science-oriented students at the time of college entry. This underrepresentation has not changed much since 1971, and is true for Whites, Blacks, Chicanas and Puerto Ricanas.

On the other hand, the academic preparation of science-bound students is more strongly related to their racial-ethnic background than to their sex. Minorities going into the sciences, regardless of gender, are less well prepared in general and, specifically, in mathematics and science than are Whites. In addition, white science students' parents are considerably better educated than the parents of minority students.

In contrast, Blacks and Hispanics appear to place more importance on becoming authorities in their fields and on making theoretical contributions to science, though the women are not quite as ambitious as the men. Although approximately equal proportions of each student group plan on earning at least a baccalaureate, minorities are more likely than Whites to aspire to earning advanced degrees.

Career aspirations show both sexual and racial-ethnic patterns and have changed over the seventies. Engineering is clearly a sex-related aspiration: although most aspiring engineers are male, women's interest in

this field increased dramatically during the seventies. Similarly, all science-oriented women, especially minority women, expressed a growing interest in medical careers over the past decade, although our data suggest a diminution of interest across all student groups at the end of the seventies. Interest in pursuing a career in scientific research decreased over the same period and, in the late seventies, was strongest among white women and weakest among Blacks and Puerto Ricans. Women's interest in careers as science teachers decreased dramatically during this nine-year period.

We are considering freshman choice of science and engineering majors or future careers as a first "success" variable, while completion of degrees and pursuit of advanced degrees and careers in science or engineering are additional "success" variables that we will be examining in the next chapter. Our data indicate that, at the point of choice, all women are disadvantaged, but that once the choice is made, white women appear to have academic and socioeconomic advantages over minority men and women. In fact, these data suggest that minority women face three barriers to scientific achievement--access (or choice of these fields), academic preparation and home background (as reflected in parental education).

"Advantage" or at least equality (again, once the choice to pursue science or engineering has been made) for minority men and women can be found only at the affective and intentional level. Their aspirations, goals and ambitions are either nearly the same as or higher than those of white students. While this could lead to frustration, given their disadvantages, minority women are striving to achieve the same "success" goals as white women and all men.

The most notable changes in the science-bound pool indicated by the trends analysis are: (1) many more science-oriented women see engineering as

a career possibility and far fewer express an interest in the more traditionally "female" careers, (2) more minority students are enrolling in four-year colleges and universities rather than at two-year colleges, and (3) generally, more students report that their parents have a college education.

In many respects, the composition and characteristics of the pool of science-oriented freshman have remained remarkably stable. This finding validates the worth of the next part of the study which focuses on what happened to the science-bound women who entered college in 1971. By examining the educational experiences of these science-oriented women and identifying factors that contributed to their success, we will be identifying at least some of the variables that are still important to science achievement. To the extent that our trends analysis does suggest changes in the freshman pool of science-bound students, we can qualify our interpretation of the findings of this longitudinal analysis.

Chapter Three

The Longitudinal Analysis

Having looked at intended behavior, as reflected in freshman major field and occupational aspirations, we then wanted to examine actual behavior to determine to what extent students realize or change their educational and occupational plans. Are science-oriented women, especially minority women who tend to enter college with a weaker academic background, more or less likely than white men to remain in science fields? Do the sciences later attract students who enter college planning to major in nonscience fields? What personal characteristics and precollege experiences predict successful completion of an undergraduate major in science, mathematics, or engineering? Do women go on to pursue advanced degrees at rates that are similar to or different from those of their white male peers? And, finally, what can we learn by comparing the occupational profiles of the four groups of women with that of white men? The longitudinal analysis addresses these questions by examining the educational and professional progress of 7,133 students who entered college in 1971 over the next eight years.

Data tracing the careers of over 10,000 members of the freshman class of 1971 were collected during the first six months of 1980, as part of a national assessment of the status and progress of minorities in higher education. This research study, supported by a grant from the Ford Foundation and conducted at the Higher Education Research Institute under the direction of Alexander W. Astin, attempted to resurvey 48,252 persons who had participated in the 1971 CIRP survey of entering college freshmen. (A copy of the follow-up survey can be found in Appendix B.) The follow-up sample was selected to include all freshmen who reported that they were Chicano (2,682), American Indian (2,336),

or Puerto Rican (768), half of the black freshmen (11,045), and approximately 10 percent of the white respondents (31,421). Black and white follow-up sample members were randomly selected from their respective cohorts in the 1971 data base. Using extensive follow-up procedures, the research team was able to collect follow-up information on about 20 percent of the sample (10,326) in early 1980. Details on the sample selection, follow-up procedures, and response rates can be found in Minorities in American Higher Education (Jossey-Bass, 1982).

The 7,133 cases selected from this data base for the longitudinal analysis included all the follow-up respondents who had earned a bachelor's degree. The main consideration in our decision to limit our analysis to persons who had received at least a baccalaureate was that our "success" measures--graduation with a science major, pursuit of an advanced degree, and professional employment in the sciences--require completion of a four-year degree program. Furthermore, the larger follow-up data base is biased in favor of college graduates and is less representative of students who did not complete a bachelor's degree. Thus, our sample selection criterion helped us to avoid problems related to nonrespondent bias in the data base.

Table 25 describes the data base used in the longitudinal analysis, by sex, race-ethnicity, and degree attainment. In comparison with their representation among respondents to the 1971 freshman survey, minorities are somewhat overrepresented in this data base. This results from the great oversampling of minority groups in the follow-up effort. Of these 7,133 college graduates, 518 majored in a physical science or mathematics, 480 in a biological science, 250 in engineering, and 30 in computer science (see Table 26). The distribution of these majors by sex and race-ethnicity reflects the underrepresentation

TABLE 25

The Longitudinal Data Base: College Graduates Who Responded to the 1971 Freshman Survey and the 1980 Follow-up Survey by Degree Achievement, Race/Ethnicity and Sex

Highest Earned Degree	Whites		Blacks		Chicanos		Puerto Ricans	
	Men	Women	Men	Women	Men	Women	Men	Women
Bachelor's	1,814	2,524	288	415	80	65	17	14
Master's	496	593	82	155	14	28	8	7
Doctorate	27	19	4	3	1	0	0	0
Professional	274	105	45	35	12	5	1	2
Total number	2,611	3,241	419	608	107	98	26	23
Percent of Total Sample	36.6	45.4	5.9	8.5	1.5	1.4	0.4	0.3

TABLE 26

The Longitudinal Data Base: Science Majors
by Field, Race/Ethnicity and Sex

Major	Whites		Blacks		Chicanos		Puerto Ricans	
	Men	Women	Men	Women	Men	Women	Men	Women
Biological Sciences	229	186	23	28	4	5	3	2
Physical Sciences and Mathematics	276	181	27	22	8	2	1	1
Engineering	198	12	23	5	8	0	4	0
Computer science	20	6	3	0	0	0	1	0
Total Number	738	385	76	55	20	7	9	3
Percent of all science majors	56.6	30.1	6.0	4.3	1.6	.6	.7	.2

of women, especially minority women, among those earning degrees in these fields. Over one-fourth (28 percent) of the white men in the longitudinal data base graduated from college with a major in one of these subject areas, as compared with 12 percent of white women, 18 percent of black men, 9 percent of black women, 10 percent of Chicanos, 7 percent of Chicanas, 35 percent of Puerto Rican men and 13 percent of Puerto Rican women. These data clearly show that women are less likely to earn a degree in these fields than are their male peers of the same racial-ethnic background. Furthermore, minority students are less likely than same-sex white students to graduate with a degree in these subjects. Although our data do not substantiate this latter statement for Puerto Ricans, our sample of 49 Puerto Ricans is too small to justify drawing any conclusions about the representation of Puerto Rican college graduates by major field.

Graduation with a Science Major

To what extent do students who enter college planning to major in science, math or engineering realize their degree goals? What fields attract students who change their major field plans? Do these scientific fields recruit college students from other fields? We addressed these questions by examining the distributions by field at graduation of students who entered college planning to major in one of our science fields and the distributions of students who majored in one of these fields by major field plans at college entry.

Biological Sciences

Looking first at what happened to the students who entered college planning to major in a biological science (see Table 27), we find that white

TABLE 27

Field Distribution at Graduation of Students
Who Entered College Planning to Major in a Biological Science

(in percentages)

Field at Graduation	Women				White Men (146)
	White (146)	Black (19)	Chicano (4)	Puerto Rican (1)	
Arts and humanities	13.7	15.8	--	--	6.2
Biological sciences	39.0	42.1	25.0	--	47.3
Business	2.7	--	--	--	4.1
Computer science	--	--	--	--	--
Engineering	--	--	--	--	0.7
Environmental science	--	--	--	--	0.7
Physical sciences and mathematics	8.2	5.3	25.0	--	15.8
Preprofessional	13.0	10.5	--	--	4.1
Social sciences	17.8	26.3	50.0	100.0	17.1
Other fields	5.5	--	--	--	4.1

men were most likely to realize their freshman aspirations. Almost half (47 percent) of the white men who, as freshmen, said they planned to major in biology did so, compared with 39 percent of white women, 8 (42 percent) of 19 black women, and one of four Chicanas. However, our list of majors includes two fields that are closely related to the biological sciences: environmental science and preprofessional fields. (This latter category includes premedical and prelaw majors but undergraduate law degrees are awarded in very small numbers and it is, therefore, safe to assume that almost all of the persons who report earning preprofessional degrees majored in premedical fields.) If we combine these three majors to assess the biological sciences' retention rate for each group, we find that just over half of the black women (53 percent), white women (52 percent), and white men (52 percent) who entered college planning to major in a biological science earned degrees in biology or in a closely related field. The premedical fields appear to attract more white and black women than white men who enter college expecting to pursue a degree in the life sciences.

What fields did the nonpersisting biology aspirants switch into? A substantial proportion became social science and arts and humanities majors, although this latter major was more popular with women than men. Some chose to major in the physical sciences, mathematics, or engineering, and this transfer was more common among men than women. The data suggest that minority women who leave the biological sciences are somewhat more likely than whites to end up majoring in a social science.

As Table 28 shows, more students graduated with a major in the biological sciences than planned to do so at college entry. What fields did these biology majors plan to major in when they matriculated? Only about 30 percent of the white students and black women who graduated with a major in biology

TABLE 28

Distribution of Students Who Graduated With a Major in the Biological Sciences by Field Plans at College Entry

(in percentages)

	Women				
Freshman Field	White (186)	Black (28)	Chicano (5)	Puerto Rican (2)	White Men (229)
Arts and humanities	8.1	--	20.0	--	1.7
Biological sciences	30.6	28.6	20.0	--	30.1
Business	--	--	--	--	0.9
Computer science	0.5	--	--	--	0.4
Engineering	0.5	--	--	--	2.6
Environmental science	1.6	--	--	--	0.4
Physical sciences and mathematics	6.5	10.7	--	--	5.7
Preprofessional	37.6	50.0	60.0	50.0	45.4
Social sciences	8.1	3.6	--	--	5.7
Other fields[a]	5.4	3.6	--	--	5.2
Missing data	1.1	3.6	--	50.0	1.7

[a]Other fields includes students who said they were "undecided."

had planned to do so as college freshmen. An even larger percentage of each group had said that they intended to earn a preprofessional degree, most probably in a premedical field. We suspect that this freshman aspiration reflects career goals rather than an understanding of college major field offerings. That is, at many institutions, students who hope to pursue medical training major in biology or chemistry as undergraduates, not in premedicine, predentistry, or preveterinary science. Small numbers of white biology majors had hoped to major in environmental science. If we combine these three fields, we find that about four-fifths of the black and Chicano women, 76 percent of the white men, and 70 percent of the white women who earned a degree in a biological science were consciously headed in that direction when they entered college.

What fields "feed into" biology? Our data show that about 8-10 percent of the white students and black women switched into biology from a science- or math-related field. Sixteen percent of the white women, 8 percent of the white men, 4 percent of the black women and one of the five Chicanas who majored in biology had entered college planning to major in the arts and humanities, the social sciences, or business. Our data suggest that Whites, especially white women, are more likely to switch into biology from fields unrelated to science or math than minority women. Clearly, it is more common for students to leave the biological sciences and closely related fields than it is for the biological sciences to attract students who enter college planning to major in nonscience fields.

Physical Sciences and Mathematics

The combined fields of physical sciences and mathematics attracted larger numbers of prospective majors among entering freshmen than the biological

sciences, except for Chicanas who were more likely to express an early interest in the life sciences. As Table 29 shows, half the white students, 37 percent of the black women, and all three Hispanic women who entered college planning to major in a physical science or mathematics did so. Almost half (47 percent) of the black women, 38 percent of the white women, and 35 percent of the white men who, as freshmen, said they planned to major in these fields ended up with a degree in what we are calling nonscience fields: the arts and humanities, business, the social sciences, and other fields. While these attrition rates into nonscience majors parallel those found in the biological sciences within a few percentage points, business attracts a larger proportion of the physical than of the biological science defectors. Women who leave the physical sciences and mathematics are less likely to enter the arts and humanities than women who leave the life sciences. The science retention rates in both the biological sciences and in the physical sciences and math are highest for white men and lowest for black women. The retention rate for white women in the biological sciences is only slightly higher than that of black women, but almost as high a proportion of white women as white men who entered college planning to major in the physical sciences or math remain in science fields.

Fewer women but more white men earned degrees in the physical sciences and mathematics than planned to do so at college entry (see Table 30). Of those students who did graduate with majors in these fields, two of the three Hispanic women, 56 percent of the white women, half of the black women, and 41 percent of the white men had planned to do so as college freshmen. Almost

TABLE 29

Field Distribution at Graduation of Students who Entered College Planning to Major in a Physical Science or Mathematics

(in percentages)

Field at Graduation	Women				White Men (229)
	White (186)	Black (28)	Chicano (5)	Puerto Rican (2)	
Arts and humanities	6.9	10.0	--	50.0	7.6
Biological sciences	5.9	10.0	--	--	5.8
Business	9.9	10.0	--	--	10.2
Computer science	1.0	--	--	--	0.9
Engineering	1.0	6.7	--	--	6.2
Environmental science	--	--	--	--	--
Physical sciences and mathematics	49.8	36.7	100.0	50.0	50.2
Preprofessional	3.9	--	--	--	2.2
Social sciences	17.2	26.7	--	--	15.1
Other fields	4.4	--	--	--	1.8

TABLE 30

Distribution of Students Who Graduated With a Major in the Physical Sciences or Mathematics by Field Plans at College Entry

(in percentages)

Freshman Field	Women				White Men (276)
	White (181)	Black (22)	Chicano (2)	Puerto Rican (1)	
Arts and humanities	8.3	4.5	--	--	4.0
Biological sciences	6.6	4.5	50.0	--	8.3
Business	1.1	--	--	--	2.9
Computer science	2.2	4.5	--	--	1.8
Engineering	0.6	--	--	--	9.4
Environmental science	1.1	--	--	--	0.4
Physical sciences and mathematics	55.8	50.0	50.0	100.0	40.9
Preprofessional	10.4	18.2	--	--	18.1
Social sciences	9.9	13.6	--	--	3.3
Other fields[a]	3.3	--	--	--	7.2
Missing data	0.6	4.5	--	--	3.6

[a]Other fields includes students who said they were "undecided."

one-fifth of the white and black women and 10 percent of the white men who graduated with degrees in the physical sciences and math entered college planning to major in the arts and humanities, the social sciences, or business. The physical sciences and math appear to attract a larger proportion of their black female and white male majors from nonscience fields than the life sciences. Again, we find that the physical sciences and math are more likely to lose prospective majors to nonscience fields than they are to recruit majors from these fields.

Engineering

Only fourteen (0.35 percent) of the almost 4,000 women in our data base reported that they planned to major in engineering when they entered college, in contrast to 9 percent of white men. None of the Hispanic women expressed an interest in this field, nor did any of them end up majoring in engineering. Half of the women and 58 percent of the white men who, as freshmen, said they wanted to earn an engineering degree did so (see Table 31). Our data suggest that white students who enter college with an interest in engineering are more likely to remain in scientific and math-related fields than those who express an interest in biology or the physical sciences and mathematics at college entry: 70 percent of the white men and women who planned to major in engineering graduated with a degree in engineering, computer science, mathematics, or a physical science.

More women and fewer men graduated with an engineering degree than hoped to do so at college entry (see Table 32). Most students who ended up with degrees in engineering entered college planning to major in engineering, computer science, mathematics, or a physical science: 80 percent of black women,

TABLE 31

Field Distribution at Graduation of Students Who Entered College Planning to Major in Engineering (in percentages)

Field at Graduation	White Women (10)	Black Women (4)	White Men (235)
Arts and humanities	20.0	25.0	4.3
Biological sciences	10.0	--	2.6
Business	--	--	6.8
Computer science	10.0	--	0.9
Engineering	50.0	50.0	57.9
Environmental science	--	--	--
Physical sciences and mathematics	10.0	--	11.1
Preprofessional	--	--	--
Social sciences	--	25.0	8.9
Other fields	--	--	7.7

TABLE 32

Distribution of Students Who Graduated
With a Major in Engineering by Field Plans at College Entry

(in percentages)

Freshman Field	White Women (12)	Black Women (5)	White Men (198)
Arts and humanities	--	--	4.5
Biological sciences	--	--	0.5
Business	8.3	--	1.0
Computer science	8.3	--	0.5
Engineering	41.7	40.0	68.7
Environmental science	--	--	1.0
Physical sciences and mathematics	16.7	40.0	7.0
Preprofessional	16.7	--	4.5
Social sciences	--	--	4.0
Other fields[a]	8.3	20.0	6.1
Missing data	--	--	2.0

[a]Other fields includes students who said they were "undecided."

76 percent of white men, and 67 percent of white women. Of the 250 students in the longitudinal data base who earned an engineering degree, only 6.8 percent were women. To put this in perspective, women accounted for 56 percent of the survey respondents in the data base.

Summary

This analysis clearly shows that students who graduate from college with degrees in science, math, and engineering are, for the most part, those who enter college planning to pursue majors in these fields. Furthermore, students are more likely to switch out of these fields to pursue other majors than they are to leave nonscience fields in order to major in science. In the biological sciences, we find that about two-fifths of the white and black women and one-third of the white men who entered college planning to major in biology ended up in nonscience fields, while only 16 percent of white women, 8 percent of white men, and 4 percent of black women who earned biology degrees had originally planned to be arts and humanities, social science, or business majors. The physical sciences and mathematics lose almost half their black female, 38 percent of their white female, and 35 percent of their white male freshmen recruits to nonscience fields and gain 19 percent of their white female, 18 percent of their black female, and 10 percent of their white male graduates from these fields. Engineering appears to lose just under 30 percent of its students to nonscience fields but recruits a small proportion of its actual majors from these fields.

White men are most likely to remain in science after entering college, followed by white and then black women. Combining all three science fields, we find that three of the five Chicanas and one of the three Puerto Rican women who hoped to earn a biology, physical science, or math degree did achieve their goal. On the other hand, of the ten Hispanic women who graduated with a

science major, only one entered college planning to major in a nonscience field.

Predictors of Undergraduate Success

We wanted to learn what personal characteristics and precollegiate experiences contributed to successful completion of an undergraduate major in the biological sciences, the physical sciences or mathematics, and engineering. In what ways did students who graduated from college with majors in these fields differ from their peers at the time of college entry? Obviously, they were considerably more likely to plan to major in a science field at the time of college entry, but that finding hardly helps us to understand the factors that contributed to their interest and success in these fields. To establish a normative profile of the successful science major, we first conducted three correlational studies using the sample of white students. The dependent variables used for this analysis were graduation with a major in (1) a biological science, (2) a physical science or mathematics, and (3) engineering. The independent variables were responses to items in the survey that students completed at the time of college entry, supplemented by the addition of responses to a small number of retrospective questions about their precollege education and environment that were asked in the 1980 follow-up survey.

The significant correlates ($p < .05$) of graduating with a major in each of these three subject areas are shown in Tables 33 (the biological sciences), 34 (the physical sciences and mathematics), and 35 (engineering). For white students, earning a bachelor's degree in one of these fields is related to high school preparation in science and mathematics, intellectual self-confidence, overall academic ability (as reflected in high school grades,

TABLE 33

Significant Correlates of Attaining a Bachelor's Degree in the Biological Sciences: White Men and Women

(N=5852)

Variable	r	p
High school preparation in science*	.14	0
Grade point average in high school	.09	0
Degree aspirations	.09	0
Mechanical ability	.08	0
Membership in high school honor society	.07	0
Academic ability	.07	0
Being male	.06	0
Intellectual self-confidence	.06	0
Father's educational level	.06	0
Science fair finalist	.06	0
High school preparation in mathematics*	.06	0
No perceived need for tutoring in science	.06	0
Father's occupation: medicine	.06	0
Mother's educational level	.05	0
Parental income	.05	0
Participated in an NSF summer program	.05	0
Mother's occupation: medicine	.05	0
Athletic ability	.04	0
Drive to achieve	.04	0
National Merit recognition	.03	0
High school preparation in reading*	.03	0
Understanding of others	-.03	0
Father's occupation: business	-.03	.02
Father's occupation: engineering	.03	0
Popularity	-.02	.04
Public speaking ability	-.02	.04
Writing ability	-.02	.04
Won a varsity letter in high school	.02	.03
Edited a high school publication	-.02	.03

*These variables were measured at the time of the follow-up (1980). All others were from the 1971 survey administered at the time of college entry.

TABLE 34

Significant Correlates of Attaining a Bachelor's Degree in the Physical Sciences or Mathematics: White Men and Women

(N=5852)

Variable	r	p
Mathematical ability	.25	0
High school preparation in mathematics*	.16	0
Academic ability	.14	0
High school preparation in science*	.14	0
Grade point average in high school	.12	0
No perceived need for tutoring in mathematics	.11	0
Mechanical ability	.11	0
Being male	.09	0
Intellectual self-confidence	.09	0
No perceived need for tutoring in science	.09	0
Membership in a high school honor society	.08	0
National Merit recognition	.08	0
Participated in an NSF summer program	.07	0
Degree aspirations	.07	0
Understanding others	-.05	0
Participated in high school speech/debate	-.04	0
Won a varsity letter in high school	.04	0
Science fair finalist	.04	0
Perceived need for tutoring in English	.04	0
Defensiveness	-.04	0
Public speaking ability	-.04	0
Social self-confidence	-.04	0
Edited a high school publication	-.03	.01
Athletic ability	.03	0
Cheerfulness	-.03	0
Drive to achieve	.03	.02
Originality	-.03	0
Popularity	-.03	0
Writing ability	-.03	.01
High school preparation in writing*	-.03	0
Father's occupation: artist	.03	.02
Father's occupation: college professor	.03	.02
Father's occupation: elementary school teacher	.03	.04
Mother's occupation: nurse	-.03	.02
Artistic ability	-.02	.04
Elected president of high school organization	.02	.02
High school preparation in reading*	-.02	.04

*These variables were measured at the time of the follow-up (1980). All others were taken from the 1971 survey administered at the time of college entry.

TABLE 35

Significant Correlates of Attaining a Bachelor's Degree in Engineering: White Men and Women

(N=5852)

Variable	r	p
Mechanical ability	.20	0
Being male	.19	0
Mathematical ability	.17	0
High school preparation in science*	.11	0
Academic ability	.09	0
High school preparation in mathematics*	.09	0
Intellectual self-confidence	.08	0
No perceived need for tutoring in mathematics	.08	0
Father's occupation: engineering	.06	0
Perceived need for tutoring in English	.06	0
Political conservatism	.05	0
Understanding of others	-.05	0
Edited a high school publication	-.05	0
National Merit recognition	.05	0
No perceived need for tutoring in science	.05	0
Won a varsity letter in high school	.04	0
Published an article or creative writing	-.04	0
High school preparation in reading*	-.04	0
Degree aspirations	.04	0
Father's occupation: elementary school teacher	.04	0
Writing ability	-.04	0
Grade point average in high school	.03	0
Father's educational level	-.03	0
Mother's educational level	-.03	0
Drive to achieve	.03	.02
Popularity	-.03	.01
Public speaking ability	-.03	.01
Sensitivity to criticism	-.03	.01
Participated in high school debate/speech	-.03	.01
High school preparation in writing*	-.03	.01
High school preparation in writing research papers*	-.03	.01
Membership in a high school honor society	.03	.01
Parental income	-.02	.03
Athletic ability	.02	.04

*These variables were measured at the time of the follow-up (1980). All others were taken from the 1971 survey administered at the time of college entry.

membership in a high school honor society, National Merit recognition, and self-ratings on academic ability), and degree aspirations. In other words, the successful major in these fields enters college with a stronger academic background, especially in science and math, greater confidence in his or her academic and intellectual ability, and higher degree objectives than his or her peers who major in other fields of study. Interestingly, freshmen's self-ratings of their mechanical ability are among the highest correlates of success in these science fields. Being male is also significantly correlated with earning a degree in each of these three subject areas, and this relationship is strongest in the field of engineering.

Personal academic variables have the highest correlations with successful completion of an undergraduate degree in science, math, or engineering. Although some family background variables (e.g., parental education, occupation, and income) and affective measures are significantly related to these success measures, these correlations are much smaller than those associated with academic measures. College graduates in science, math, and engineering appear to differ from their peers not so much in terms of socioeconomic background, attitudes, or self-concept as on measures of academic performance, preparation, especially in math and science, self-confidence, and aspirations.

Looking at specific subject areas, we note that biology majors were above-average students in high school, entered college with higher degree aspirations than the average freshman, participated in science-related activities prior to entering college, and had fairly well educated parents. Physical science and mathematics majors entered college with the strongest background in mathematics, were even better all-around students than biology majors, were not particularly verbal or socially adept, and apparently came from "average" homes (neither parental education nor income are significantly correlated with major-

ing in these subjects). Participation in a National Science Foundation (NSF)-sponsored summer program for high school students was significantly correlated with completion of majors in both the biological and physical sciences. Engineering majors were well defined by these correlations as being mechanical, mathematical and male. They are the one group whose major is distinctly related to a parental occupation--having a father who is an engineer. Parental education has a slightly negative relationship with this major, indicating that engineering majors' parents tend to be somewhat less well educated than the average freshman's parents.

Keeping in mind that these correlations establish a kind of normative profile of the successful major in each of these three science fields, we now want to examine the variables that differentiate women who major in these subjects from their female peers.

Predictors of Undergraduate Success for Women

Are the variables associated with successful completion of an undergraduate major in these subjects by women the same as those that differentiate white science majors from their peers who major in other fields? The trend analysis showed that women are less likely than men to aspire to scientific majors and careers at the time of college entry, and that minority women are especially unlikely to express an interest in the sciences, math, and engineering. Furthermore, minority students who do plan to pursue training and careers in the sciences tend to have a weaker academic background that science-bound white students. The numbers of minority women in our data base who actually graduated with degrees in science, math, and engineering are very small: 55 Blacks, 7 Chicanas, and three Puerto Ricans. Thus, it was not possible to conduct separate analyses of success predictors for minority women.

Our analysis focuses on how women science, math, and engineering majors differ from their female peers at the time of college entry. We hope that our findings will suggest ways in which elementary and secondary schools can increase women's chances of success in these traditionally male fields.

Half of the 444 women in our longitudinal data base who majored in science, math, or engineering earned a degree in the biological sciences, 46 percent held degrees in the physical sciences or mathematics, and only 17 (4 percent) majored in engineering. Separate regressions were run to identify the variables associated with undergraduate success in each of these three subject areas. The results of these analyses are presented in tables that report not only the beta value and the multiple R but also, for purposes of comparison, the simple correlation coefficients of each variable with the dependent variable for women and for white students (the normative r). The reader should also remember that the technique of multiple stepwise regression compensates for problems of covariance.

Table 36 clearly shows that high school grades are the best predictors of successful completion of an undergraduate major in biology for women. Mechanical ability is a highly significant predictor of graduating with a biology major, as is participation in an NSF summer program. Women who major in biology tend to perceive themselves as less popular than their peers as entering freshmen, and their mothers are better educated than average. They also rate their mathematical ability higher than other freshmen women. To this point, we find no striking differences between the variables that characterize women biology majors and those that describe white biology majors. However, the simple correlation coefficients tend to be somewhat higher for women than for white students. This means, for example, that women biology majors had even better high school grades and higher self-ratings on mechanical and

TABLE 36

Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in the Biological Sciences: Women

Predictor	B	R mult.	r	normative r
Grade point average in high school	.054	.119	.119	.09
Mechanical ability	.057	.146	.098	.08
Participated in an NSF summer program	.059	.161	.079	.05
Popularity	-.045	.170	-.054	-.02
Mother's educational level	.078	.177	.062	.05
Mother's occupation: doctor	.044	.183	.054	.05
Mathematical ability	.039	.194	.106	.07
Originality	.045	.199	.053	*
No perceived need for tutoring in mathematics	.050	.203	.021	*
Published an article or creative writing in high school	-.032	.207	-.028	*
Degree aspirations	.034	.216	-.064	.09
Music contest participant	-.033	.214	-.021	*
Academic ability	.054	.217	.112	.07
Writing ability	-.036	.220	-.010	-.02
Mother's occupation: college professor	-.037	.222	-.021	*
Understanding of others	-.036	.225	-.047	-.03

*No significant correlation found for normative groups.

mathematical ability than did white biology majors. In a group that is already "above average" on these measures, women stand out as being especially talented.

Some of the variables that were significant predictors of graduating with a biology major for women were not significantly correlated with this outcome for the normative group. For example, women biology majors saw themselves as more original, as less likely to need special assistance in mathematics, and were less likely to report having participated in a music contest compared with other freshmen women, although none of these variables differentiated white biology majors from their peers. Women biology majors also felt less confident of their ability to express themselves in writing and entered college with lower degree aspirations than the average freshman women, a reversal of our finding that white biology majors had high degree aspirations than their peers.

Taking all the significant predictors into consideration, we can account for about 5.1 percent of the variance between women who major in biology and those who choose other fields. Given that our list of variables includes only measures of family background, precollege experiences, and self-concept and excludes freshman major field plans, it is quite useful. The data suggest that educators can improve young women's chances of succeeding in biology by as much five percent, if they encourage girls to work for and maintain good grades, to develop mechanical skills and self-confidence, to participate in extracurricular or supplemental science activities such as NSF-sponsored summer programs, and to improve their mathematics skills by enrolling in advanced courses.

Self-rating of one's mathematical ability is the critical predictor of graduating with a major in the physical sciences or mathematics (see Table 37). Since this self-rating was made at the time of college entry, it probably re-

TABLE 37

Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in the Physical Sciences or Math: Women

Predictor	B	R mult.	r	normative r
Mathematical abilty	.206	.256	.256	.25
Grade point average in high school	.069	.264	.160	.12
Writing ability	-.045	.269	-.030	-.03
Academic ability	.078	.273	.163	.14
Understanding of others	-.039	.275	-.056	-.05
Music contest participant	-.032	.278	-.019	*
Father's occupation: elementary school teacher	.035	.280	.040	.04
No perceived need for help in mathematics	.044	.282	.106	.11
No perceived need for help in science	.036	.285	.083	.09
Perceived need for help in English	.031	.286	.038	.04
Artistic ability	-.036	.288	-.023	-.02

*No significant correlation found for normative group.

flects self-confidence as well as quality of high school preparation and past success in mathematics. Past academic performance is also important to graduation with a mjaor in these fields, but the simple correlation coefficients underscore the importance of mathematics: mathematical ability alone accounts for 6.6 percent of the variance and high school grades alone account for only 2.6 percent of the variance. All the significant predictors combined account for 8.3 percent of the variance between women who major in these fields and their peers in other fields. Strong math preparation and self-confidence in math is the overriding success predictor for these fields and women's chances of succeeding in the physical sciences and math are substantially increased by a firm foundation in high school mathematics. Both elementary and secondary educators can influence women's math preparation by watching for signs of math anxiety and helping women to overcome this barrier, by encouraging women to select the more challenging math courses rather than general or business math alternatives, and by advising women to take advanced elective courses in mathematics.

The number of women in our sample who graduated with a major in engineering is very small (17). Thus, we must exercise caution in generalizing from the results of the regression shown in Table 38. Again, we find that freshman self-ratings on mathematical ability are the best predictor of graduation with a major in this field. Interestingly, the next best predictor is a below-average freshman self-rating on sensitivity to criticism. The data suggest that women engineering majors are not only good students, especially in math, but are also able to withstand or ignore negative reactions to their decision to enter such a male-dominated field. These women also rate themselves as being more politically liberal than other women, in direct constrast to the below-average self-rating of the normative engineer on this variable. For women,

TABLE 38

Standardized Regression Coefficients and Multiple and Simple Correlation Coefficients of Significant Predictors of Attaining a Bachelor's Degree in Engineering: Women

Predictor	B	R mult.	r	normative r
Mathematical abilty	.046	.071	.071	.17
Sensitivity to criticism	-.048	.086	-.048	-.03
National Merit recognition	.047	.098	.056	.05
Mechanical ability	.044	.106	.058	.20
Writing ability	-.045	.114	-.035	-.04
Poltical liberalism	.025	.119	.03	-.05

success in engineering appears to be related to academic talent (as reflected in National Merit recognition, not high school grades), strong mathematics skills and self-confidence, mechanical ability, and a fair amount of independence. All of these traits can be nurtured and developed by elementary and secondary educators.

We were surprised by how few of our ninety-nine independent variables proved to be significantly related to majoring in these fields and how relatively unimportant measures of family background were. Academic ability and, especially, mathematical ability emerged as the major predictors of women's successful completion of majors in these fields. Measures of verbal, artistic, and social skills, when they reached significance, tend to show that these science-oriented women see themselves as less able to express themselves in writing, less artistic, less musical, and less perceptive about understanding others than women in nonscience fields. However, the major differences between women who major in science, math, and engineering and other women college students are in quantitative skills, academic performance and, to some extent, mechanical ability or inclination. Socioeconomic background, including parental occupations, and affective measures do not appear to contribute much to our ability to differentiate these two groups of women. This finding indicates how important the school influence in emphasizing mathematics and science preparation for women can be in enabling women to succeed in these fields.

Pursuit of Advanced Degrees

This phase of our longitudinal analysis examines the transition from college to graduate and professional programs. It looks at advanced degree program attendance rates and major field choices of students who earned undergraduate degrees in the biological sciences, the physical sciences or math,

and engineering. It also examines the undergraduate majors of women and white men who enter graduate programs in these fields.

Biological Sciences

Of the students who earned bachelor's degrees in the biological sciences, 75 percent of the black women, 72 percent of the white men, 61 percent of the white women, two of five Chicanas, and one of two Puerto Rican women went on to pursue advanced degrees. As Table 39 shows, all three Hispanic women, 59 percent of white men, 48 percent of black women, and 44 percent of white women went into professional programs in medicine, dentistry, or veterinary medicine. Graduate programs in the biological and environmental sciences attracted about one-third of the white women, one-fourth of the black women, and one-fifth of the white men. Thus, 78 percent of the white men, three-fourths of the white women, 71 percent of the black women, and all three of the Hispanic women who had earned bachelor's degrees in biology and subsequently went on to pursue further education entered a program that was closely related to their undergraduate field. The biology majors most likely to pursue advanced degrees in fields totally unrelated to the sciences were black women, 29 percent of whom entered graduate programs in the arts and humanities, business, the social sciences, and "other" fields, compared with 18 percent of the white women and 16 percent of the white men.

Turning to Table 40, we find that about four-fifths of the students who entered graduate programs in the biological sciences had majored in biology as undergraduates. Not surprisingly, very few biology graduate students report that their college major was in a nonscience field. If we go even further back in these students' educational careers, we find that their interest in scientific quantitative fields was evident when they entered college (see Table 41).

TABLE 39

Advanced Degree Fields of Undergraduate Majors in the Biological Sciences

(in percentages)

Advanced Degree Field	Women				White Men (165)
	White (114)	Black (21)	Chicano (2)	Puerto Rican (1)	
Arts and humanities	0.9	4.8	--	--	1.2
Biological sciences	28.9	23.8	--	--	18.2
Business	3.5	9.5	--	--	6.7
Computer science	--	--	--	--	1.2
Engineering	1.8	--	--	--	0.6
Environmental science	2.6	--	--	--	1.2
Physical sciences and mathematics	4.4	--	--	--	3.6
Professional	43.9	47.6	100.0	100.0	58.8
Social sciences	6.1	4.8	--	--	6.1
Other fields	7.9	9.6	--	--	2.4

TABLE 40

Distribution of Graduate Students in the Biological Sciences, Physical Sciences and Mathematics, and Engineering by Undergraduate Major

(in percentages)

Undergraduate Major	Biological Sciences				Math and Physical Sciences			Engineering		
	WW (42)	BW (6)	CW (1)	WM (39)	WW (58)	BW (8)	WM (96)	WW (13)	BW (4)	WM (75)
Arts and humanities	4.8	--	--	2.6	5.2	--	2.1	--	--	1.3
Biological sciences	78.6	83.3	--	76.9	8.6	--	6.3	15.4	--	1.3
Business	2.4	--	--	2.6	--	--	2.1	--	--	2.7
Engineering	--	--	--	--	--	--	2.1	15.4	25.0	73.3
Physical sciences and mathematics	2.4	--	100.0	12.8	75.9	100.0	82.3	46.2	75.0	12.0
Preprofessional	4.8	--	--	--	--	--	1.0	--	--	--
Social sciences	4.8	--	--	5.1	10.3	--	1.0	23.1	--	4.0
Other fields	2.4	16.7	--	--	--	--	3.1	--	--	5.4

WW = White women, BW = Black women, CW = Chicano women, WM = White men.

TABLE 41

Distribution of Graduate Students in the Biological Sciences, Physical Sciences and Mathematics, and Engineering by Major Field Plans at College Entry

(in percentages)

	Biological Sciences				Math and Physical Sciences			Engineering		
Freshman major	WW (42)	BW (6)	CW (1)	WM (39)	WW (58)	BW (8)	WM (94)[a]	WW (13)	BW (4)	WM (75)
Biological sciences	38.1	50.0	100.0	38.5	6.9	12.5	10.6	23.1	--	1.4
Physical sciences and mathematics	7.1	--	--	7.7	51.7	50.0	44.7	23.1	50.0	9.5
Engineering	--	--	--	--	--	--	11.7	--	25.0	64.9
Computer science	--	16.7	--	--	--	12.5	--	7.7	--	1.4
Environmental science	2.4	--	--	--	1.7	--	1.1	--	--	2.7
Preprofessional	26.2	33.3	--	41.0	10.3	12.5	7.4	23.1	--	4.1
Other fields	26.2	--	--	12.8	29.4	12.5	24.5	23.1	25.0	16.0

WW = White women, BW = Black women, CW = Chicano women, WM = White men

[a]Information on the freshman major field plans of 2 of the 96 white male graduate students was not available.

All six of the black women who entered graduate programs in biology entered college planning to major in a science field, as did 87 percent of the white men, 74 percent of the white women, and the one Chicana graduate student in biology.

Physical Sciences and Mathematics

All three of the Hispanic women, 73 percent of the black women, 72 percent of the white men, and 60 percent of the white women who earned a bachelor's degree in a physical science or mathematics enrolled in advanced degree programs. Just over two-fifths of the white men and women and half of the black women entered graduate programs in the field of their undergraduate major (see Table 42). Interestingly, college graduates who majored in the physical sciences or math are more likely to leave the scientific and quantitative fields than are biology majors: two-fifths of the white women, one-fourth of the black women, and 22 percent of the white men entered graduate programs in the arts and humanities, business, social sciences and "other" fields. However, these "defectors," who move mainly into business and the social sciences, may well be math majors whose quantitative skills would provide a strong and relevant foundation for success in graduate programs in these fields. All three Hispanic women remained in the sciences, but switched from the physical to the life sciences: two began medical training and one went into a graduate program in the biological sciences.

The path into a graduate program in the physical sciences and mathematics is as narrow as that leading into graduate programs in the biological sciences. As Table 40 shows, all eight black women, 82 percent of the white men, and 76 percent of the white women who entered graduate programs in the physical sciences and mathematics had majored in these fields as undergraduates.

TABLE 42

Advanced Degree Fields of Undergraduate Majors in the Physical Sciences and Mathematics

(in percentages)

Advanced Degree Field	Women				White Men (186)
	White (108)	Black (16)	Chicano (2)	Puerto Rican (1)	
Arts and humanities	2.8	6.3	--	--	1.6
Biological sciences	0.9	--	50.0	--	2.7
Business	15.7	--	--	--	11.8
Computer science	5.6	--	--	--	5.4
Engineering	5.6	18.8	--	--	4.8
Environmental science	--	--	--	--	1.1
Physical sciences and mathematics	40.7	50.0	--	--	42.5
Professional	7.4	6.3	50.0	100.0	22.0
Social sciences	17.6	18.8	--	--	6.5
Other fields	3.7	--	--	--	1.6

Again, we find that very few graduate students moved into these fields from a nonscience undergraduate background. Going back to their degree plans at college entry (Table 41), we find that about half the white and black women pursuing graduate degrees in the physical sciences and math and 45 percent of the white men were planning to earn their undergraduate degrees in these same fields. Somewhat larger proportions of graduate students in these fields than in the biological sciences started college intending to major in a non-science field or undecided about what field they would major in: 29 percent of white women, one-fourth of white men, and one of the eight black women.

Engineering

Students who earned bachelor's degrees in engineering were less likely to go on to graduate school than biology, physical science, and math majors: their graduate school attendance rates were 52 percent for white men and 47 percent for women. Just over half (54 percent) of the white male engineering majors who went to graduate school and three of the eight women (38 percent) remained in engineering; business attracted another 30 percent of the men and two women (Table 43). Almost three-fourths (73 percent) of the white male graduate students in engineering held undergraduate engineering degrees, as compared with only three (18 percent) of the 17 women. As Table 40 shows, most engineering graduate students earned their bachelor's degrees in scientific and quantitative fields. Furthermore, 65 percent of these men entered college planning to study engineering and only 16 percent expressed an interest in a nonscience field (Table 41). In contrast, only one (6 percent) of the 17 women who pursued graduate degrees in engineering had expressed such an early interest in the field and four (24 percent) weren't even planning to major in science fields.

TABLE 43

Advanced Degree Fields of Undergraduate Majors in Engineering

(in percentages)

Advanced Degree Field	White Women (5)	Black Women (3)	White Men (102)
Arts and humanities	--	--	2.0
Business	40.0	--	30.4
Computer science	--	--	2.9
Engineering	40.0	33.3	53.9
Environmental science	--	33.3	1.0
Physical sciences and mathematics	--	--	2.0
Professional	20.0	--	3.9
Social sciences	--	--	2.9
Other fields	--	33.3	1.0

Our data document the growing appeal of engineering among women in this sample. Engineering is the only one of the three subject areas where we find more women graduate students than undergraduate majors. Of the 17 women who earned an undergraduate degree in engineering, ten were "recruits" who began college with other major field plans. Of the 17 women graduate students, 14 were recruits who held undergraduate degrees in other fields. Clearly, these women who entered college in 1971 considered the possibility of a career in engineering much later than they thought about careers in other science fields.

Summary

Students who earn undergraduate degrees in the biological sciences appear to go on to pursue graduate and professional degrees at somewhat higher rates than physical science and mathematics majors. White men who majored in these fields had higher graduate and professional school attendance rates than white women. Although our sample of minority women was very small, the data suggest that these women were especially high achievers: black women went on for advanced degrees at slightly higher rates than white males and two-thirds of the Hispanic women entered advanced degree programs, a higher rate than those of white women. Engineering majors had the lowest graduate school attendance rate, about 50 percent for both men and women.

Most students pursue advanced degrees in the field of their undergraduate major or in a closely related field. It is interesting to note that five of the Hispanic women entered professional fields, presumably medical programs, and one went into a graduate program in the life sciences, although three had earned their bachelor's degrees in the physical sciences. The physical sciences and mathematics lost the largest proportions of their undergraduate majors to non-science graduate programs, primarily business and the social sciences. However,

we suspect this higher attrition rate may be caused by math majors in search of job-related training in fields where they can apply their quantitative skills. Men appear to be somewhat more likely than women to remain in science and technical fields, and engineering undergraduate majors are least likely to switch into graduate programs in nonscience fields, assuming that graduate programs in business represent an additional credential toward careers in technical fields for these students.

Three-fourths or more of the graduate students in the biological sciences, the physical sciences and mathematics, and engineering hold undergraduate degrees in the field in which they are pursuing advanced degrees, except for women graduate students in engineering. The students who are recruited into these fields at the graduate level usually come from other science fields. Furthermore, if we look back to see what fields these students were interested in as college freshmen, we find that the vast majority planned to earn degrees in science fields if not in the same field they are currently pursuing their graduate training in.

Our data do suggest that white women were more likely to express a late interest in science, moving from nonscience to science undergraduate majors and from nonscience undergraduate majors to graduate programs in the sciences at higher rates than their male peers. Nonetheless, these late recruits account for small proportions of the baccalaureate-recipients and even smaller proportions of the graduate students in science, math, and engineering. Most students who pursue graduate degrees in these fields entered college expressing strong interest in the sciences.

Occupational Choice

Finally, we looked at the jobs our science-oriented respondents held at the time of the follow-up survey, over eight years after they entered college. Our analysis examines the occupational patterns of students who entered college planning to major in the biological sciences, the physical sciences or math, and engineering, of students who earned undergraduate degrees in these fields, and of students who enrolled in graduate programs in science, math, or engineering.

Biological Sciences

Not surprisingly, students who earned undergraduate degrees in the life sciences were more likely to hold biology-related jobs than were all freshmen who planned to major in biology (Tables 44 and 45). Five occupational categories had obvious linkages to the biological sciences: conservationist or farmer which included foresters and ranchers, lab technician or hygienist, nurse, physician or dentist, and scientific researcher. One-third of the white men and women, 26 percent of the black women, and two of the five Hispanic women who entered college planning to major in biology held such jobs, as compared with about half of the white students, 36 percent of the black women, and three of the seven Hispanic women who majored in biology. White students appear either to look for or to successfully find jobs in these categories at a higher rate than black women.

Looking more closely at these occupational categories, we find that white men are far more likely than women to report that they are doctors, dentists, conservationists, or farmers. Women, on the other hand, report that they are lab technicians or hygienists more often than men. Women who entered college planning to major in biology are more likely to become nurses than their

TABLE 44

Occupations of Students Who Entered College Planning to Major in a Biological Science

(in percentages)

Occupation	Women				White Men (147)
	White (147)	Black (19)	Chicano (4)	Puerto Rican (1)	
Business person	15.6	31.6	25.0	--	16.3
College teacher	2.0	--	--	--	2.0
Computer programmer or analyst	0.7	5.3	--	--	2.7
Conservationist or farmer	2.0	--	--	--	6.1
Elementary or secondary educator	15.0	15.8	--	100.0	8.2
Engineer	2.0	--	--	--	1.4
Lab technician or hygienist	6.8	5.3	25.0	--	3.4
Lawyer	--	--	25.0	--	1.4
Nurse	4.8	5.3	25.0	--	--
Physician or dentist	4.8	5.3	--	--	12.2
Scientific researcher	15.0	10.5	--	--	11.6
Other occupations	31.3	21.1	--	--	34.7

TABLE 45

Occupations of Students Who Majored in the Biological Sciences

(in percentages)

Occupation	Women				White Men (229)
	White (186)	Black (28)	Chicano (5)	Puerto Rican (2)	
Business person	11.3	17.9	--	--	15.3
College teacher	4.8	--	--	--	1.3
Computer programmer or analyst	1.1	3.6	20.0	--	1.3
Conservationist or farmer	1.1	--	--	--	5.2
Elementary or secondary educator	8.1	10.7	--	--	7.4
Engineer	2.2	--	--	--	0.9
Lab technician or hygienist	11.3	7.1	--	--	5.7
Lawyer	--	--	--	--	0.4
Nurse	1.6	--	--	--	1.3
Physician or dentist	14.5	14.3	--	50.0	28.8
Scientific researcher	21.5	14.3	40.0	--	7.4
Other occupations	22.6	32.1	40.0	50.0	24.9

male peers and than biology majors, suggesting that students with an interest in nursing switch from biology to nursing majors during the college years. Women who earn degrees in biology appear to find employment in scientific research at higher rates than white males. In sum, white men appear to go into traditionally male fields at higher rates than women, while women are more likely than men to end up in jobs where they are providing support services for professionals.

The two other occupational categories that employed substantial proportions of prospective and actual biology majors are business and education. Although men who earned degrees in biology tend to enter these fields at about the same rates as men who express an early interest in earning a degree in biology, women who majored in biology are less likely to be in business and education than all women who entered college planning to major in biology. Elementary and secondary education attracted more women than men, although this disparity is less evident among students who earned their degrees in biology. Business occupations (accountant, actuary, business executive, owner, salesperson, or buyer) were more popular among black women than white students, and this difference is more pronounced among prospective than actual biology majors.

Because so few members of our sample went on to attend graduate school in the biological sciences, it is difficult to say much about the occupational distributions shown in Table 46. Of the three student groups, those who go on to graduate school are most likely to be involved in scientific research. About eight years had passed since these students first entered college, more than sufficient time to complete a master's but barely long enough to earn a doctorate. We expect that persons who report college teaching as their occupation are graduate students working as teaching assistants or instructors, since faculty positions in the sciences are scarce even for PhDs and usually

TABLE 46

Occupations of Students Who Entered Graduate Programs in the Biological Sciences, the Physical Sciences or Mathematics, and Engineering

(in percentages)

Occupation	Biological Sciences				Math and Physical Sciences			Engineering		
	WW (42)	BW (6)	CW (1)	WM (39)	WW (58)	BW (8)	WM (97)	WW (13)	BW (4)	WM (75)
College teacher	16.3	--	--	5.1	8.6	--	10.3	7.7	--	4.0
Computer programmer or analyst	4.7	16.7	--	--	12.1	25.0	9.3	7.7	--	2.7
Elementary or secondary educator	9.3	33.3	--	10.3	19.0	25.0	8.2	7.7	--	4.0
Engineer	2.3	--	--	--	1.7	12.5	6.2	30.8	75.0	69.3
Lab technician	4.7	--	--	17.9	1.7	--	--	--	--	1.3
Scientific researcher	32.6	33.3	--	28.2	25.9	25.0	29.9	23.1	25.0	1.3
Other occupations	30.1	16.7	100.0	38.5	31.0	12.5	36.1	23.1	--	17.4

WW = White women, BW = Black women, CW = Chicano women, and WM = White men.

require several years of postdoc research experience. Thus, white women are either more likely than white men to pursue PhDs or, more probably, women graduate students tend to end up working as teaching assistants and men as research assistants (lab technicians). Our data suggest that black women are more likely than whites to become educators, presumably high school biology instructors who hold a master's degree. Combining the categories of lab technician and scientific researcher, we find that white men are better represented than women in positions that clearly reflect involvement in research.

In brief, students who earned degrees in the biological sciences were more likely to hold related jobs than were all freshmen who expressed an interest in biology. White students were somewhat more likely than black women to hold biology-related jobs, while black women were more likely to go into business and education than their white peers. Men ended up working as professionals at higher rates than women, while women were more likely to hold jobs that provided staff support for professionals. Students who went on to pursue advanced degrees were most likely to be working in research-related jobs, with more white men than women reporting such employment.

Physical Sciences and Mathematics

The four occupational categories that are most logically related to majors in the physical sciences and mathematics are computer programmer or analyst, lab technician, physician or dentist, and scientific researcher. About one-fourth of the freshmen who planned to major in the physical sciences or math hold such jobs, as compared with 31 percent of the white women, 36 percent of the black women, and 37 percent of the white men who did major in

the physical sciences or math (see Tables 47 and 48). White female majors lag behind their male and black female peers in finding jobs related to their undergraduate fields. White women and black women majors go into jobs in the computer fields at higher rates than white men, while the men are more likely to become doctors and dentists.

Substantial proportions of the prospective and actual majors in the physical sciences and math hold jobs in business, education, and engineering. Business attracts more prospective than actual majors. Among whites, more prospective than actual majors and more women than men end up working as school teachers, administrators, and counselors. Black women were most likely to become educators and more actual than propsective majors went into education. Engineering also attracted more black women than white students.

If we compare the occupational profiles of students interested in biology with those of students interested in the physical sciences and math, we find biology-oriented students were more likely to become conservationists or farmers, nurses, physicians or dentists, lab technicians and scientific researchers. Students interested in the physical sciences and math were more likely to end up in computer-related jobs, engineering, education, and, except for white men and black women majors, business. Among students who earn degrees in these fields, men become doctors and dentists at twice (in the biological sciences) to three times (in the physical sciences) the rate of women. Although women biology majors hold research-related and lab tech jobs at much higher rates than their white male peers, this is not the case among physical science and math majors where white men are somewhat better represented in these positions than white women. Women, especially black women, are more likely than men to go into education. Business and computer fields appear to be especially attractive to black women.

TABLE 47

Occupations of Students Who Entered College Planning to Major in a Physical Science or Mathematics

(in percentages)

Occupation	Women				White Men (226)
	White (204)	Black (30)	Chicano (1)	Puerto Rican (2)	
Business person	25.5	30.0	--	50.0	23.5
College teacher	2.9	--	--	--	4.9
Computer programmer or analyst	13.7	10.0	--	--	10.2
Conservationist or farmer	0.5	--	--	--	0.9
Elementary or secondary educator	21.1	26.7	--	--	10.2
Engineer	5.9	16.7	--	--	7.5
Lab technician or hygienist	2.0	--	100.0	--	1.3
Lawyer	1.0	--	--	50.0	1.8
Nurse	0.5	--	--	--	0.4
Physician or dentist	2.0	--	--	--	4.9
Scientific researcher	7.4	16.7	--	--	8.0
Other occupations	17.7	--	--	--	26.6

TABLE 48

Occupations of Students Who Majored in the Physical Sciences or Mathematics

(in percentages)

Occupation	Women				White Men (276)
	White (181)	Black (22)	Chicano (2)	Puerto Rican (1)	
Business person	21.5	9.1	--	--	13.8
College teacher	2.8	--	--	--	5.1
Computer programmer or analyst	14.9	18.2	--	--	11.6
Conservationist or farmer	2.8	--	--	--	0.4
Elementary or secondary educator	19.3	36.4	--	--	7.6
Engineer	5.5	13.6	--	--	5.1
Lab technician or hygienist	1.7	--	50.0	--	1.8
Lawyer	--	--	--	100.0	1.1
Nurse	0.6	--	50.0	--	--
Physician or dentist	2.8	--	--	--	8.7
Scientific researcher	11.6	18.2	--	--	14.5
Other occupations	16.6	4.6	--	--	30.4

Looking at the occupations reported by students who went on to pursue advanced degrees in the physical sciences and math (Table 46), we again find that these students are most likely to be involved in scientific research, though less likely than graduate students in the biological sciences. On the other hand, students who attend graduate school in the physical sciences and math are much more likely than biologists to be employed as computer programmers or analysts and, except for white women, as engineers. As in biology, we find no black women reporting college teaching as their occupation. However, black women are again most likely to be working as elementary and secondary educators, and we find that white women who attended graduate school in the physical sciences or math report this as their occupation at over twice the rate of their male peers.

In sum, students who majored in the physical sciences and math were more likely than all freshmen who considered majoring in these fields but less likely than biology majors to hold jobs clearly related to their undergraduate field of study. We suspect this reflects a wider range of life sciences-related job opportunities for bachelor's degree-recipients than for physical sciences and math majors. On the other hand, physical science and math majors are more likely than biology majors to go into engineering which requires quantitative skills, and into education. White women who major in the physical sciences and math were less likely than their male and black female counterparts to hold related jobs. Students who went on to pursue graduate degrees were most likely to hold jobs related to the physical sciences and math and research positions.

Engineering

Prospective and actual engineering majors are most likely to hold jobs related to their field of interest. Of the fourteen freshman women who expressed an interest in engineering, half became engineers and three (21 percent) held jobs in the related field of computer science (see Table 49). About half the white men who entered college planning to major in engineering were working as engineers, computer programmers, or analysts. Students who actually majored in engineering were even more likely to be engineers: 88 percent of the women and 64 percent of the men. Of the three subject areas, engineering is the only one in which women end up working in positions related to their major at higher rates than their white male peers. This suggests that those few women who expressed an interest in such a traditionally male field were both quite certain of their interest and capable of achieving it. The remaining two women and 12 percent of the men who earned degrees in engineering held jobs in the business sector. None of the black women who were interested in engineering went into elementary and secondary education, although the other science fields lost substantial proportions of their black women students to careers in this field. Interestingly, students who entered graduate programs in engineering reported a more diversified range of occupational pursuits than engineering majors (see Table 46). Only four of the thirteen (31 percent) white women who attended graduate school were employed as engineers at the time of the follow-up, as compared with 69 percent of the white men. Women were, however, more likely than men to report employment in scientific research.

TABLE 49

Occupations of Students Who Entered College Planning to Major in Engineering and of Students Who Majored in Engineering

(in percentages)

Occupation	Prospective Majors			Actual Majors		
	White Women (10)	Black Women (4)	White Men (236)	White Women	Black Women	White Men
Businessperson	10.0	--	16.1	16.7	--	11.6
College teacher	--	25.0	0.4	--	--	--
Computer programmer or analyst	20.0	25.0	5.9	--	--	2.0
Conservationist or farmer	--	--	0.8	--	--	--
Elementary or secondary educator	10.0	--	4.7	--	--	2.0
Engineer	50.0	50.0	43.2	83.3	100.0	64.1
Lab technician	10.0	--	0.4	--	--	0.5
Lawyer	--	--	1.7	--	--	0.5
Physician or dentist	--	--	2.1	--	--	--
Scientific researcher	--	--	3.0	--	--	2.5
Other occupations	--	--	21.6	--	--	16.7

Summary

Students who actually major in the biological sciences, the physical sciences or math, and engineering are more likely to be employed in jobs related to their field of study than are students who plan to major in these fields as college freshmen. Engineering majors are most likely to hold jobs related to their field, followed by biology majors. If we compare the occupational profiles of prospective and actual majors in these fields, we find that students' occupational choices tend to reflect their freshman major field interests, and that biologists find research-related jobs more often than physical science and math majors. Women, especially black women, are much more likely than men to end up working in elementary and secondary schools. Students who go on to pursue advanced degrees are most likely to be working in research, biologists more than physical scientists and mathematicians and male biologists more than their female peers. Assuming that graduate school attenders who report they are currently educators are math and science teachers, more women, particularly black women, than men who pursue advanced degrees in the sciences and math are working in jobs that are clearly related to their academic interests and backgrounds.

Conclusion

The longitudinal data presented in this chapter show that most students who earn undergraduate degrees in science, math, and engineering enter college planning to major in these or closely related fields of study. Many science-oriented freshmen change their major field plans from one science or math-related field to another during the undergraduate years and, to a lesser extent, on entry into advanced degree programs. The sciences, math and

engineering also lose substantial proportions of their prospective and actual majors who decide to major or pursue graduate degrees in nonscience fields. However, the proportions of science, math, and engineering majors and graduate students who switch into these fields from nonscience fields are far smaller than the proportions of prospective and actual science majors who leave the sciences. It is evident that precollegiate influences are the major determinants of interest and success in sciences, mathematics, and engineering.

Men are not only more likely than women to enter college planning to major in the sciences, math and engineering, they are also more likely to graduate with a degree in their intended major and in science generally than are women who share their freshmen aspirations. However, it is encouraging to find that white women who do earn bachelor's degrees in these science fields are more likely than their male peers to be recruits from nonscience fields: 19 percent of the white women who majored in the physical sciences and math, 16 percent of those who majored in the biological sciences, and 8 percent of those who majored in engineering were planning to major in the arts and humanities, business, or the social sciences as college freshmen, compared with 10, 8, and 10 percent, respectively, of the white males who received degrees in these fields.

Our findings regarding minority women's persistence in and recruitment to these fields are less promising. Black women who entered college planning to major in the sciences switched to nonscience fields at higher rates than their white peers of either gender, and this disproportionate attrition was especially pronounced in the more quanitative fields (the physical sciences and math and, to the extent that we can generalize from the behavior of four women, engineering). Furthermore, a substantially smaller proportion of black women (4 percent) than of the white students who earned degrees in the bio-

logical sciences entered college planning to major in a nonscience field. The science recruitment rate for black women in the physical sciences and math is considerably higher and almost identical to that of white women. Of the five black women who earned degrees in engineering, four entered college planning to major in a science field. Ignoring our concern about how few Chicano and Puerto Rican women even express an interest in science fields, we find that half of the eight Hispanic women who entered college planning to major in the sciences or math ended up majoring in nonscience fields, the highest science attrition rate of any group. Furthermore, only one of the ten Hispanic women who graduated with science or math majors entered college planning to major in a nonscience field, the lowest overall science recruitment rate.

The data do indicate that those black women who earn a bachelor's degree in the sciences are high achievers: black women who majored in the sciences and math had higher graduate and professional school attendance rates than any other group. However, we suspect that this may reflect a kind of screening out or deselection from the science pool of all but the most talented and determined black women. That is, the trends analysis showed that black women were less likely than black men to express an interest in science majors and careers as college freshmen. The longitudinal analysis shows that their ranks are further reduced by disproportionately high attrition from the sciences during the undergraduate years. This line of reasoning leads us to expect that among science majors who go on to pursue advanced degrees, black women would be most likely to remain in scientific and technical fields. While the data for engineering majors do bear out our assumption, the numbers of women are too small to draw any conclusions. In the physical sciences and math, black women majors' rate of attrition from the sciences into nonscience

graduate programs is substantially below that of white women and only slightly higher than that of white men. However, black women who graduated with degrees in the biological sciences entered nonscience graduate programs at a substantially higher rate than white students. Thus, the sciences continue to lose talented black women in the transition from college to advanced study at a higher rate than they lose white men and, in the biological sciences, white women.

Of the ten Hispanic women who earned undergraduate science degrees, two-thirds went on to graduate or professional school. Thus, they were more likely than white women but less likely than white men and black women to pursue advanced degrees. They were the students most likely to remain in the sciences: five went to medical school and one entered a graduate program in the life sciences. Clearly, engineering, mathematics, the physical sciences (except as a route to medical training) and research held little appeal for Hispanic women.

In brief, white men were most likely to enter college planning to major in science, math or engineering in 1971. They were more likely to remain in the sciences than were science-oriented women, especially minority women. They went on to pursue advanced degrees at about the same rates as black women but at higher rates than Hispanic and white women. They were also more likely than white and black women to enter graduate and professional programs in scientific and technical fields. When we compare the occupational profiles of science majors, we find white men were much more likely than women to become medical professionals (doctors or dentists). The trends data suggest that women who entered college in subsequent years may be better represented in this field. Although male and female biology majors went into teaching careers at comparable rates, women who earned degrees in the physical

sciences and math, especially black women, were much more likely than white men to pursue careers in elementary and secondary education. Engineering majors are the students most likely to be employed in jobs closely related to their undergraduate field.

Looking back at high school influences, we find that preparation in mathematics and science are the best predictors of majoring in science, math, and engineering during college. Strong precollegiate preparation in these subjects is essential to completing an undergraduate degree, pursuing graduate training, and entering careers in these and related fields. Most students who major in science enter college planning to do so. The pool of prospective science majors simply becomes smaller during the undergraduate years, while the pools of prospective social science, arts and humanities, and business majors increase in size. If high school mathematics and science preparation through coursework, extracurricular and supplemental activities, and counseling is strengthened and a special effort is made to reach women, it logically follows that the pool of prospective science majors will expand, become more diversified, and the success rates of these students will improve.

In order to understand more about the influences and dynamics that lead women to pursue training and careers in the sciences, the third and final phase of our study involved in-depth interviews with women scientists, mathematicians, medical professionals, and engineers.

Chapter 4

Profile of the Interview Sample

The study design called for interviews with thirty women pursuing careers in science, mathematics, and engineering. The purposes of the interview phase of the project were to help us understand and interpret the survey findings, to provide us with a more in-depth picture of the dynamics influencing educational and career choices, and to supplement the small numbers of minority women in the survey data base. Because the interviews were intended to complement the survey research data, we wanted to talk with women who were relatively close in age to the survey respondents in the longitudinal data base. The age range for inclusion in the interview sample was defined as 26-34. Because an advanced degree is a prerequisite to achieving a professional position in most scientific and technical fields, we sought to identify women who had earned or were pursuing graduate or professional degrees. In keeping with our sampling objective of identifying approximately equal numbers of women from each of the four target groups, we interviewed nine white, seven black, seven Mexican-American, and seven Puerto Rican women. To ensure some measure of geographic diversity, interviews were conducted on the East Coast (New Haven, New York City and northern New Jersey, and Washington and its Maryland suburbs), in the Southwest (Albuquerque, Houston, and Los Alamos, New Mexico) and in California (greater Los Angeles and the San Francisco Bay area).

The interviews were conducted over about six months, beginning in mid-May 1981. We identified interview sample members through a review of the questionnaires returned by the longitudinal analysis sample which yielded six subjects; through a review of questionnaires that had been completed by

recipients of Ford Foundation fellowships for graduate study who participated in a recent study conducted by the Higher Education Research Institute, yielding 11 subjects; through contacting professional associations, yielding eight subjects; and through individual referrals which identified five subjects. Only one woman who was invited to participate in the study refused, pleading overwork and family obligations. The interviews were conducted in person with the exception of one interview with a woman in Boston that was conducted by telephone due to scheduling problems.

Interviews averaged about two hours and were loosely structured to follow the interview protocol in Appendix C. The interview covered each woman's educational and work history; her family background and current marital and parental status; the development of her interest in science, mathematics, or engineering and in a career in one of these fields; and her thoughts on why so few young women express an interest in scientific or technical careers and about what might be done to counteract this tendency. Although we can't generalize about women scientists and engineers based on the individual experiences of 30 women, their responses reflect themes and ideas that suggest how young women become interested in these fields and how their interest can be encouraged along the way. They also provide information about the educational experiences of women who have recently completed or who are still pursuing degrees and about the early phases of their career development. These data allow us to examine how successful efforts to eliminate bias have been and what kinds of barriers, if any, must be addressed in order to provide equal educational and occupational opportunity.

Age, Field, and Occupational Status

Thirteen of the 30 women interviewed were under age 30 and eight had entered college in 1971, the year in which the members of the longitudinal

data base were freshmen. Table 50 shows the age distribution of the interview sample. Vetter points out:

> . . . most aspiring scientists will find an advanced degree is necessary for employment beyond the technician level. Engineers and computer specialists, on the other hand, can find employment opportunities with only a bachelor's degree. (1980, p. 5)

Seventeen of our interviewees hold PhDs, and three are pursuing doctorates. Three hold professional degrees in medical fields, and two, including one who has earned a PhD, are pursuing medical degrees. Four have earned master's degrees and two hold bachelor's degrees in technical fields, engineering and computer science. As Table 51 shows, even without counting the medical professionals, about half of the interview sample are in the biological science fields. Women are better represented in the biological sciences than in the physical sciences both in our sample and among recent doctorate-recipients. Unpublished preliminary tabulations from the National Center for Education Statistics show that, in academic year 1978-79, almost equal numbers of doctorates were earned in the biological sciences (N=3,205) and in the physical sciences and mathematics (N=3,185). However, over two times as many women earned doctorates in the biological sciences (N=822) as in the physical sciences and mathematics (N=392).

These women were following a range of career paths in a variety of settings. At the time of the interviews, eleven were working as research or technical staff members, six were postdoctoral fellows and one was a resident physician, five were students, three held tenure-track faculty positions, three had moved into administrative positions within a scientific facility or technically oriented company, and one was in the process of relocating after completing a degree. Of the 24 who were employed, nine worked at a university

Table 50

Distribution of the Interview Sample by Age and Race/Ethnicity

Age	Black	Chicana	Puerto Rican	White	Total
26-28	1	2	2	6	11
29-31	2	4	3	-	9
32-34	4	1	2	3	10

Table 51

Distribution of the Interview Sample by
Field of Highest Degree and Race/Ethnicity

Field	Black	Chicana	Puerto Rican	White	Total
Biological Sciences[a]	4	4	3	3	14
Anatomy					1
Biochemistry					3
Botany					2
Genetics					1
Ichthyology					1
Microbiology					2
Molecular Biology					1
Pharmacology					1
Physiology					1
Virology					1
Medical Fields[a]	1	1	2	-	4
Dentistry					1
Medicine					3
Physical Sciences and Mathematics	1	-	1	4	6
Chemistry					2
Geophysics					1
Mathematics					1
Physics					2
Technical Fields	1	2	1	2	6
Computer science					1
Engineering					5

[a]One woman who is classified as a biological scientist on the basis of her PhD is currently enrolled in medical school.

or at a university-affiliated medical center, research institute or national lab; six worked in government research facilities; seven were in the private sector, including two who worked for a prime government contractor; one worked at a botanical garden and the resident physician was employed by a hospital.

We are not qualified to judge how talented or "good" these women are as scientists, doctors, or engineers nor did we seek professional evaluations of their work or potential. Our impression, based on their educational and professional accomplishments and their enthusiasm about their work, is that they are, at the very least, highly competent in their chosen fields. Furthermore, having examined the data, we suspect that women who have pursued scientific and technical careers despite the attitudes and pressures that militate against these choices had to have considerable talent as well as the curiosity, the love of science or math, and the stubbornness to which they attribute their persistence and achievements.

Family Background

For the most part, these women report that their parents were neither especially well-educated nor well-to-do. Three-fifths described their family's financial status as "poor" to "lower middle class" during the years when they were growing up. Only three white women said they came from "middle to upper-middle-class" families. One-third reported that at least one of their parents had earned a bachelor's degree and an eleventh woman said that one parent (her mother) had received a B.A. two years ago. As Tables 52 and 53 show, white women's parents tended to have completed somewhat more education than the parents of our other interviewees. During the interviews, one-third of the women mentioned that economic circumstances or family obligations had

Table 52

Father's Education at Time Interviewee Entered College by Race/Ethnicity

Educational Level	Black[a]	Chicana	Puerto Rican	White	Total[a]
8th grade or less	3	4	3	-	10
High school graduate	1	-	2[b]	3	6
Business or vocational training	-	2	-	1[c]	3
Some college	-	-	-	1	1
College graduate	1	-	2[b]	3	6
Master's or professional degree	1	1	-	1	3

[a]One black respondent was raised by her mother and provided no information about her father.

[b]Three Puerto Rican respondents reported that their fathers had earned a GED when they were children and one of them had gone on to earn his bachelor's degree.

[c]One white respondent reported that her father had left school after 8th grade but had subsequently received vocational training.

Table 53

Mother's Education at Time Interviewee Entered College by Race/Ethnicity

Educational Level	Black	Chicana	Puerto Rican	White	Total
8th grade of less	-	4[b]	3	-	7
Some high school	2	-	-	-	2
High school graduate	2	1	2[c]	4	9
Vocational training (nursing)	-	-	1	1	2
Some college	1	1	-	2	4
College degree	1[a]	1	1	2	5
Master's degree	1	-	-	-	1

[a]Bachelor's earned when respondent was a child.

[b]One of these women earned her GED recently with her daughter's assistance.

[c]One of these women received her bachelor's degree two years ago.

prevented one of their parents from realizing his or her educational aspirations. A Puerto Rican women reports: "My father was brilliant. Unfortunately, he was poor. He got up to the 8th grade and later, in the army, he finished high school. He bought us encyclopedias and I think that he'd read them before we knew how to use them." One Chicana and one Puerto Rican woman reported that their fathers had wanted to be doctors, a white woman said her father's unrealized ambition had been to become a vet, and a black woman said her mother had once dreamed of attending medical school.

Only two women, a black physician and a Chicana scientist, had fathers who had worked in a scientific or technical field; both were engineers. About one-third said their fathers were laborers or held skilled or semi-skilled jobs (see Table 54). One-third reported that their mothers had never worked outside the home and another six said their mothers had stayed home to raise their children before entering or reentering the labor force. None of the black women had had nonworking mothers and only one reported that her mother had waited until her youngest child was in school before seeking a job. As Table 55 shows, all of their mothers had chosen traditionally "female" occupations, although an interest in mathematics or science is reflected in four careers: an accountant, a bookkeeper, a high school math teacher, and a grade school science and math teacher.

These women grew up in families that ranged in size from one to ten children. White women tended to come from somewhat smaller families and Mexican-Americans from larger families (see Table 56). Like Malcom, Hall, and Brown (1976), we found no particular birth-order pattern: eight were "only" or first-born children and seven were youngest children. Of the 22 who had older siblings, 14 had older brothers. In addition to the three "only" children,

Table 54

Father's Principal Occupation by Race/Ethnicity

Occupation	Black[a]	Chicana	Puerto Rican	White	Total[a]
Blue collar	3	3	2	3	11
Small business owner	1	1	-	-	2
Military or civil service	-	2	2	-	4
Salesman or buyer	-	-	2	3	5
Professional	2	1[b]	1	3	7

[a]One black respondent was raised by her mother and provided no information about her father.

[b]Trained as an engineer, he left the profession to manage the family business.

Table 55

Mother's Principal Occupation by Race/Ethnicity

Occupation	Black	Chicana	Puerto Rican	White	Total
Homemaker	-	3	3	4	10
Teacher or nurse	2	1	3	-	6
Family business	1	1	-	-	2
Business sales or office work	1	-	-	5	6
Laborer or low-skilled job	3	2	1	-	6
(reentered job force	1	-	2	3	6)

Table 56

Number of Children in Family by Race/Ethnicity

Number of Children	Black	Chicana	Puerto Rican	White	Total
1	1	-	1	1	3
2-3	2	1	3	6	12
4-5	2	1	3	2	8
6-10	2	5	-	-	7

nine had no brothers. Of the 22 who had older siblings, three were the first child in the family to attend college and an additional seven were the first to complete a bachelor's degree. One black woman was raised by a single parent and one reported her father died when she was 12. In two cases (a white and a Puerto Rican woman), the subject's parents were divorced when she was in her early teens.

Seven of the 30 women (four of them Puerto Rican) reported that their families had made a major move during their precollege years. Only one of the seven Puerto Rican women had been born and raised on the mainland (in northern New Jersey), although two had moved to New York City during grade school: one after completing first grade and the other after sixth grade. Two had attended school in Europe and on the East Coast as Army dependents before returning with their families to the Island where they entered junior high and remained through the undergraduate years. Two grew up in Puerto Rican and didn't come to the mainland until they started graduate school. The Chicanas were from the Southwest: four grew up in Texas, two in California, and one moved to Los Angeles from Mexico after completing ninth grade. Unlike Malcom, Hall, and Brown (1976), we found only one had been raised in a small town or rural environment. The black and white women grew up across the country. The black women tended to come from urban areas. The only one who had lived in a small town moved to a city after her father's death when she was 12. Four white women grew up in major cities, three in suburban communities; three grew up in small to medium-sized cities; and two were from small towns. In sum, the Puerto Rican women came from the most mobile families, although their families and the Chicanas' families lived within very specific regions of the country. Black women were most likely to come from major cities.

Uniformly, these women report that doing well in school and getting an education were family values. A doctoral student says: "My father felt that the only way that people could get ahead was through education. He felt that school was our job and there was no reason why we shouldn't do well in school." This concern is reflected in the fact that two-fifths of these women--four Puerto Ricans, three Whites, three Chicanas, and two Blacks--received some or all of their precollegiate education in Catholic schools, although several reported that this had strained family finances. Another two black women reported that their parents were so concerned about the quality of the local school that they were pulled out to attend schools with reputations for academic excellence: one was transferred to an otherwise all-white public school, the other was sent to a private university's lab school.

Only two women said that there was ever any question about whether or not they would go to college and only one reported family opposition to her desire to go to college:

> They didn't think it was for a girl in the first place, and they couldn't see the benefit at all. They thought it was a selfish thing, that only rich kids go to college so that they can goof off and not worry about making a living.

Their opposition gradually changed to pride as the customers at the store where her mother worked as a grocery checker expressed their admiration for her daughter's achievements. Two other women said their families couldn't understand why they wanted to continue in school after earning a bachelor's degree. This reaction appears to reflect both cultural and socioeconomic factors: all were from Hispanic families and their parents had received little formal education. They were concerned about whether pursuing such atypical educational and professional goals would eliminate their daughters' prospects for achieving

a satisfactory personal life. A black scientist reported that her mother had expressed similar concerns but that her father strongly supported her decision to go to graduate school.

Marital and Parental Status

Half of the women we interviewed were married--five of the Puerto Ricans, four of the Whites, and three each of the Blacks and Chicanas--and one was engaged. Of the fourteen single women, two had been married previously; one of them got married at the end of her freshman year in college and the other had married during her second year of medical school so that she could adopt her niece, whose mother had died. Of the fifteen women who were currently married, one had married at age 21, three had married at age 24 or 25, seven at age 26 or 27, and four between the ages of 28 and 31. Six got married while they were in graduate or professional school; one, while she was working between advanced degrees; three, as they were completing their highest degree; and five, after they had earned advanced degrees and entered the work force. Of the fourteen single women, five were white, four black, four Chicano, and one was Puerto Rican. With the exception of three black women, women who had never married were still in their late twenties.

Motherhood was a role that these women had recently assumed or were currently planning, for the most part. Only two women had combined parental responsibilities with being a student: the woman who had adopted her niece and the woman who had married at 21. Both children were now ten-year-olds. Only three other women had children and, of the five, only one had two children. None had interrupted their career in order to stay at home with their children.

Conclusion

It is evident from this demographic profile that the thirty women we spoke with were high achievers. They were also articulate, dynamic, and attractive. Regardless of differences in their family backgrounds, all of them report that they were encouraged and expected to do well in school. As they pursued their interests in their fields, each exceeded her parents' educational attainments. Although the daughter's choice of a scientific or technical field sometimes surprised her parents, they supported her decision even when they had to keep asking what field she was in and what she did. Only one woman, a Puerto Rican, reported that her family actively opposed her decision to seek an advanced degree, firm in their belief that "it's a man's place to become a professional, not a woman's." With the exception of this one woman, who feels her parents are still upset by her nontraditional choice, these women report that their parents take great pride in their accomplishments.

Chapter 5

Reinforcers of an Orientation toward Science and Math

How did these thirty women happen to become interested in science or math? What nurtured their interest and encouraged them to pursue careers in scientific and technical fields? The interview data help us to understand what people and experiences play important roles in encouraging and in discouraging an interest in scientific and technical fields.

Seven of the women we interviewed said that they couldn't remember a time when they weren't interested in science or math and only seven report that their interest developed as late as high school. Some can pinpoint a particular experience that stimulated their interest: for one, being hospitalized several times during her preschool years; for another, being singled out as "good in math" during third grade by the principal, a woman mathematician, who encouraged her. Most attribute their interest in science or math to a combination of influences that reinforced one another. The most frequently mentioned influences were an early curiosity and fascination about how things worked, where they came from, and why they were the way they were; family support for and encouragement of these interests; discovering in school that science or math was interesting and that they did well in these subjects; an outstanding science or math teacher; school field trips or special science-oriented summer programs that provided exposure to and involvement in conducting experiments and seeing what scientists do; and watching television coverage of the space program or reading books about scientists and science that captured their interest.

The elementary and secondary school years are critical in terms of exposing girls to science and math and nurturing their interest. Although only six of these women entered college with a specific career goal and only three of them realized their original goal, their interest in science, math, or engineering was firmly established by the time they left high school. Only five report having ever considered a social science or humanities college major and only two actually declared a major in one of these fields: one quickly discovered that she neither liked nor did well in psychology courses, the other had entered college planning to major in biology but was so intimidated at orientation that it took her two years and several majors to build up confidence in her ability to succeed in science.

Math and science do have a reputation for being difficult subjects and our respondents feel that this is one reason why there aren't more young women in scientific and technical fields. A geneticist who makes an effort to attend high school career days reports:

> Many of the people who advise them [girls] tell them that the sciences and math are extremely hard and they won't be able to handle it because it's too difficult. They're constantly fed that kind of information and, sooner or later, they begin to believe it. Naturally people listen to other people.

In fact, several of the women we interviewed regret having avoided or postponed taking particular math or science courses that they feared were too difficult. A pharmacologist who avoided physics until her senior year in college says she would probably have earned her graduate degree in biophysics had she not felt that she would have had to go back and complete an undergraduate major in physics in order to get ahead in the field.

Half of our interviewees described their high school instruction in science or math as excellent and nine participated in accelerated or honors

programs in these subjects. Regardless of their current field, they emphasized the importance of a strong math background. In reflecting on their educational experiences, about two-thirds made remarks like "I've always been very good in math," "I really enjoyed math," or "my math instruction was superior."

Not surprisingly, they see underpreparation in science and, especially, in math as a major problem. An endocrinologist traces young women's lack of interest in science careers to the fact that

> very early in their school experience, they're not given courses in math or encouraged to do things that prepare them for the "male" fields. They'll avoid those courses until it's too late and they don't have the background. It's very difficult to get a solid background and compete if you start late. Math is especially critical in all areas of science.

Our respondents feel that both teachers and parents often expect girls to do poorly in these subjects and don't seem concerned when they live up to this expectation or avoid these subjects entirely. A mathematician says: "I think we let up on girls. We say, 'You don't have to learn this--that's okay.' That's not good. They do have to learn it." Fox reports that "more than half the college-bound group of today's women are entering college without the prerequisite mathematical background for entrance into the higher paying technical fields" (1981, p. 14). The importance of a strong high school math background for a growing number of fields is underscored by a survey of a recent graduating class at UCLA. Three-fifths of these graduates had majored in fields that required three years of math before students could begin work in the major (cited in Scully, 1981).

High School Advising

Whom do young women turn to for advice and guidance during these critical high school years? The interview data suggest that school counselors were more

often a hindrance than a source of assistance to women with nontraditional aspirations. This impression is consistent with past research which has found that counselors are "remembered by young and adult women more for their discouragement rather than their encouragement of the pursuit of science careers" (Fox, 1981, p. 25). Twelve women either couldn't remember ever going to see a counselor or found them to be of little or no help. Eight had received some educational or career guidance. Typically, it focused on presenting the "how to's" of applying to college, but did little to help them clarify or focus their interest in science or math. A graduate of a Catholic high school that offered more services than most women recall explains why well-intentioned efforts to provide career counseling weren't helpful:

> They would bring in brochures and have career days, but they were always the predictable ones--lawyers and doctors. The spectrum is so much more varied. If you like science, you don't just want to be a doctor or a "scientist." A scientist covers so many fields from studying the stars to studying the atom. It didn't give you enough background. You only saw these main categories and you couldn't really relate to that at all.

The other women who had attended career days or received some kind of high school career counseling concurred with her assessment.

Our interviewees identified this as a persisting problem and as another reason that more young women never consider careers in scientific and technical fields. An engineer says, "No one knows what an engineer does." A woman who rediscovered her childhood interest in geology during college reports: "Geology isn't taught in high school so I quit thinking about it as a discipline you could go into." A black engineer pointed out that lack of information and exposure to these kinds of careers is a special problem for young people from low-income communities since they are unlikely to have any personal contact with professionals in these fields: "There were no engineers on my street or

in my community. My counselor didn't know anything about engineering, but she was the head counselor and so we respected what she said." What she said when this young woman told her that she wanted to major in engineering or math was: "Those fields wouldn't be good for you. Those fields are for men and you're so feminine."

Although that counselor simply tried to redirect her advisee's interests, suggesting journalism as a more appropriate field, seven women--all minorities--reported that their high school counselors had tried to lower their educational and career aspirations. The valedictorian of her high school class was advised that the local community college might be a better place for her than the university. A woman who had decided in fourth grade that she wanted to become a doctor was told that, if she liked science, she should consider a career in nursing. A high school freshman who needed a counselor's signature to enroll in Latin reports:

> She told me she was sick of people coming in with high ideas. After all, I was colored and I was a woman and I should realize that I shouldn't be going into science and that I couldn't make it in science. I think she was trying to be helpful. She said if people failed to realize that they had certain limitations in life, they would never be happy.

She didn't get to take Latin and she never went to see a high school counselor again. Her impression that the counselor was trying to be helpful is echoed by a Chicana who said: "If you can survive counselors, you're doing well. Maybe they see it as not encouraging people who won't succeed or who can't succeed because of financial reasons but, if you want to try, they won't give you that opportunity."

Counselors can help young women realize their aspirations, judging from the experiences reported by two women who were encouraged by competent,

nonjudgmental counselors. The one woman whose family did not want her to go to college was advised to transfer to a public school by her parochial high school counselor who explained that if she hoped to major in science in college, she needed to take math and science courses that the Catholic school did not offer. She entered the public school in twelfth grade and immediately went to the academic counselor:

> I wanted someone to tell me how to get into college. She was very kind. I think she really liked working with students who showed that much interest and follow-through. We worked together to lay out plans for what to do that senior year. She even helped me to apply for some scholarships and I won one. She made sure I took all the right college admissions tests and helped me take them for free. Thanks to her, I got into college. If it hadn't been for her, there wouldn't have been anyone else.

The other woman who had received very helpful high school counseling had attended a Catholic girls' school that had an educational and career guidance center with a 15-member staff. Yet she reports: "Even in my high school, the big push was for secretarial and executive assistant roles. We weren't encouraged to go into nontraditional jobs."

The people who are remembered as a source of information--and often of inspiration--and advice are individual teachers. Twenty-one of the 30 women mentioned specific teachers who had been instrumental to the development of their interest in science or math. Another, who had received outstanding instruction at Bronx High School of Science, was at a loss to single out an individual teacher. Of the women who mentioned a particular teacher, 16 identified women; in three instances, the teacher's sex was not specified. A black PhD who attended a segregated high school reported that the first person to encourage her interest was a high school teacher who held a master's degree in biochemistry:

> She encouraged all of our interests in science. I think her teaching has led more minorities to become doctors and researchers than anyone I've ever met or heard of. She was very good at what she did, very talented, very demanding, and always encouraging. She laid the groundwork for college: It was easy to make "A's" in college.

Another woman vividly remembers her 10th grade biology teacher as a knowledgeable woman whose love of biology made a real impression on her. She also remembers the physics teacher who divided the senior class into those who would take physics--theoretically an elective course--and those who would take typing:

> Physics was a very good class. The nun was extremely stern--not a warm person that you could talk to--but, in many respects, she introduced the whole class to the scientific way of thinking: how to be organized; how to present a scientific report; how to write up your results from a lab; and how to go to the library, conduct research, and get your citations correctly. That was very useful later on.

The interview data suggest that one of the most effective ways in which we can encourage more young people to consider scientific and technical careers is to make high school teaching attractive to people who are knowledgeable and enthusiastic about biology, chemistry, physics, algebra, and calculus.

It is interesting to note that, of the eight women who did not recall outstanding high school teachers, three were essentially adopted by a woman professor for whom they worked as undergraduate research assistants, one by a woman graduate student who also worked for the professor who employed her, and one by a male professor of her ethnic background. These mentors played critical roles in the educational and professional development of these five women. The sixth was assigned to a woman advisor when she decided that taking a few graduate courses might improve her chances of getting into veterinary school. The advisor's enthusiasm for and excitement about her work were contagious and the personal relationship that developed was so strong that the student moved halfway across the country when her advisor accepted a job at

another university. The seventh woman was guided and encouraged by a male student of her ethnic background who was several years ahead of her in professional school. The eighth woman had spent four years in college trying and rejecting one science-related major after another until a classmate suggested engineering. She became actively involved in the school's minority engineering program and in the student chapter of the Society of Hispanic Professional Engineers. She credits these contacts, as well as the tutors who were available to her through the school's program, for her persistence through four additional years of college:

> Being with a group of people who shared similar problems as a result of a poor educational background in math and science meant you didn't feel such a dummy. We also had tutors in math, physics, chemistry, and engineering. I really think that a lot of my success is because of how much help I got from the minority engineering program.

This woman had by far the weakest high school science and math background of any woman we interviewed. After immigrating to the U.S. from Mexico, she received almost no math or science instruction from 10th through 12th grade.

Role Models

Our respondents feel that role models play a critically important role in expanding the range of career options that girls consider. The individuals they most often cited as their role models were teachers, usually high school teachers, and older women students in their field.* Of course, one reason that professors were cited as role models less often than teachers were is that these women encountered fewer and fewer women as they proceeded to each higher educational level. Fourteen spoke of women science or math teachers they had had in junior high or high school as role models and a fifteenth cited a woman lab technician whom she had been assigned to work with as part of a biomedical

*It is interesting to note that 12 of these 30 women attended a Catholic grade and/or high school where most, if not all, of their teachers were women.

careers program for high school students; eight were encouraged by women professors during their undergraduate years, while ten don't remember there being any women faculty members in their undergraduate department; and only four had women graduate advisors.

Simply seeing or knowing about a woman who is succeeding in a particular field can be important. A women whose two graduate advisors were men describes carefully watching as a young professor in her field set up her lab, gained the respect of her colleagues, and had a baby: "If I ever had any doubts about being able to do it, that dispelled them." A second woman considered becoming a geologist until the college geology professor told her that, as a woman, her chances of working in the field or as a project director were slim to nonexistent. She became a botany major because "there seemed to be opportunities for women:" She had met a woman who taught botany at a university and she had heard about a woman who had a national reputation in the particular subfield she was interested in. How many young women don't know of women who have entered and succeeded in nontraditional fields and are persuaded by this kind of "disinterested" advice from counselors or teachers?

We often assume that an opportunity to work with a woman professor or professional in one's field is among the most positive experiences a young woman can have. The interviews suggest that this is not always how things work out: the experience is either very positive or especially disheartening. Of the four women whose graduate advisors were women, two were supported and encouraged by women whom they admired and who became personal friends. The other two report a difficult experience working under what they perceived to be unnecessarily strict supervision from a woman they were not able to get along with and didn't like. Both advisors were "new" faculty members, although both were described as "older" women who had worked in the field for some time in other

professional positions. Our respondents were their first graduate students and, while their advisors were concerned that they do well, they also wanted to insure that there would be no grounds for accusations of favoritism toward women students. Both students recognized that, in many respects, their advisors were in a more isolated and difficult situation than they were in, yet this provided slight consolation. One chose to leave the institution after earning her master's degree rather than continuing to work with that advisor.

If the first women scientist, mathematician, or engineer that a young woman meets is defensive and unfeminine, has difficulty getting along with her colleagues, has no personal or family life, and seems to resent her, the young woman's immediate response is to wonder: Is this how I will or must become to get ahead in the field? Even a few such unattractive characteristics would be more than enough to discourage many young women. Fox reports:

> A study by Stake and Granger (1978) found that among high school seniors, males and females with the highest science career commitment were those who had same-sex teacher models whom they perceived as moderately or highly attractive; and students with the lowest science career interest were those who had same-sex models whom they perceived as low in attractiveness. (1981, p. 25)

One of our respondents remembers the summer that she first worked with a woman in her field, a woman who clearly neither liked nor trusted her student assistant and who refused to explain the purpose of the work that they were doing. The student was distressed and discouraged when she returned to college that fall. An elderly professor reassured her that she had had an unfortunate experience with a particular individual and explained that older women had had to overcome so much resistance in order to enter and advance in the field that some had become tough and defensive and resented the comparatively easy access and rapid promotion enjoyed by young women. He was able, she said, to relieve her anxiety "without

dumping on women." There is still some rivalry among women, notes a young physicist: "It wasn't so neat being the only woman, but at least you were special."

A kind of corollary to this is that, for many young women, it's essential to know that pursuing a scientific or technical career doesn't mean that they will have to sacrifice other aspects of their life. About one-third of the women we interviewed cited relatives or family friends among their role models. Though not scientists, these role models were strong, energetic, interesting women who had successfully managed job and family responsibilities. A black PhD explained why her mother immediately came to mind when she was asked if she had had any role models:

> I'm still impressed by the fact that she got an education when not many women did and she had a master's degree. She had a family and she worked. Everything these women talk about now as being so revolutionary, my mother was doing back when I was a little girl.

Certainly, men can also model this behavior and a few women reported that their role models had been men. One identified her undergraduate advisor:

> I wanted to pattern my life after his. I felt that if I had to be like one of those guys who just do geology and work hard and are always terrified about competition, I didn't want to do it. People who have an emotional life, a personal life, a cultural life, and an intellectual life beyond geology but who are also really good geologists and devoted to geology are my role models--that's what I want.

She had the good fortune of finding a similarly well-rounded and highly respected scientist to work with in graduate school

Another woman, who had been guided and encouraged by a woman she greatly admired during her undergraduate years, had a very different experience in graduate school:

> I became kind of disillusioned with research because of the role model I had in my advisor: He was very gung-ho, always in

> the lab on weekends, and had no family life whatsoever. He was very young and I always predicted that he'd die young of a heart attack because he pushed himself too much. Then I looked around and saw that most people were doing that. I always believed that you could pursue a career, pursue research even, and still have a somewhat balanced life. To me, it doesn't mean much if there isn't something else balancing that out to meet the more social needs you have.

She reconsidered her goal of becoming a faculty member and chose to begin her professional career in a work environment that she considers to be less stressful and demanding than a postdoc or assistant professorship and that offers greater job security.

Lack of role models and a poor image of science and scientists led one woman, an engineer, to dismiss the idea of a science career when it was suggested during her high school years. After taking a battery of tests at a private career advisement center, she was advised to consider a career in oceanography. She described her response: "I thought they were crazy. I couldn't imagine being a scientist. It sounded austere and I thought it meant cutting out everything I'd enjoy." She didn't discover that she liked science until her senior year in college and she spent the following year working at a laboratory that gave her release time and paid her fees to take courses at the local university. Once the deficiencies in her undergraduate background were remedied, her employer sent her to graduate school. She reports:

> The professors seemed to be able to see me as a woman but in no way detracting from my being a professional engineer. That was very important to me. Until then, I had seen my job as a good job until the other aspects of my life--marriage and a family--came through. I got past that as I interacted with the other women students, the woman professors, and the male professors. It was the first time I saw that a professional life and a well-rounded social and personal life could go together.

Today, she regrets never having explored the idea of a career in oceanography.

Asked why she thought so few young women consider scientific and technical careers, she responded: "As a young woman, I saw myself looking more for an image than for a career. I think engineering jobs are not seen as being as prestigious as law or being a business professional." A PhD observed that "science doesn't come off as a glamorous career as medicine and law do." Young women find the stereotypic image of a woman scientist--"someone serious with thick glasses and out of fashion"--distinctly unappealing, noted another scientist. Thus, our respondents feel that early exposure to the range of career opportunities in scientific and technical fields and to professionals, particularly women, who are excited about their work is essential to overcoming these stereotypes about science and scientists.

Some of the women we interviewed reported that they had found their role models by reading biographies. Marie Curie was the most frequently mentioned biographical role model, although the list included both male scientists and women who had achieved in other fields. The astronauts were also frequently cited either as role models or as having stimulated an early interest in science. Several respondents commented on the impact that the media have in American society. They feel that the media can play an important role in encouraging scientific and technical achievement by presenting women (and minority) doctors, scientists, and engineers in films, advertisements, and book illustrations. Progress is being made on this front, particularly in children's books, but there is still considerable room for improvement. A television commercial that was being broadcast while the interview data were being collected began with a woman in a lab coat announcing that she was a chemist. The picture expanded to show her in a kitchen as she confessed that she wasn't <u>really</u> a chemist, but she used a number of products in her kitchen that were made by the chemical company

sponsor. Instead of challenging sex-role stereotypes, the advertising agency and the chemical company (which does employ women chemists) simply used the "unusual" idea of a woman chemist to capture the audience's attention and then presented a woman in the most traditional role and setting possible. A girl who saw this particular commercial could certainly form the impression that it was ridiculous to imagine a woman as a chemist.

Research Exposure

It would be difficult to overstate the importance of hands-on experience conducting research: It exposes young women to scientists who are excited about their work, tests and confirms their interest in science, generates enthusiasm, develops skills, and builds confidence. Four of our interviewees had participated in special science programs for high school students: two were summer programs sponsored by NSF, one was a summer program supported by the American Heart Association, and the fourth was a year-long government-sponsored program that combined coursework during the school year with a summer apprenticeship. Describing her experience in an NSF summer program, the molecular biologist says:

> It was an intensive exposure to science: we were immersed in it. We may not have actually learned that much, but we learned whether we wanted to go into science. . . . That experience was what finally made me decide on a career in science. The people who taught were not great scientists, but they really cared about science and that impressed me.

These minority women agree that this high school experience was critical to their decision to pursue careers in science.

An additional eight women had some kind of similar intensive, hands-on experience during their undergraduate years: Six in summer programs, two of which were again sponsored by NSF; one in a six-month off-campus program at a

national lab; and one as a co-op student in a program sponsored by the Navy that required her to work in a lab during the summer and alternate academic terms for three of her five undergraduate years. One said it was this experience that showed her she would be happy doing research, another said she learned that she wanted to be more than a technician, and a third said: "It made me think of myself more in professional terms and showed me that I could make it." In an interesting variation on this theme, a ninth respondent reported that she dropped out of graduate school after a summer laboratory job confirmed her suspicion that she would not be happy pursuing a research career. She accepted a job as coordinator of a summer program for minority undergraduates who hoped to pursue careers in the health sciences. The exposure she received as program coordinator renewed her earlier interest in medicine:

> I discovered all the flexibility that medicine has. With an MD, I could do a lot of things I wanted to do politically and scientifically and, in fact, it was the only way to combine the interest I have in science with the interest I have in counseling people and working with them.

At the time of the interview, she was in her third year of medical school.

Two of the women who had had off-campus research experience as undergraduates and an additional five women held on-campus jobs during their college years that provided similar exposure. One woman who was placed in a work-study job with a woman biochemistry professor reports:

> She was very encouraging. She gave me the confidence to go ahead and apply to medical school, in spite of the fact that there weren't very many women going into medicine then or very many Puerto Ricans. But I was doing research with her and the research was going well and I understood that. She even had me present a paper and helped me get elected to [a professional society]. And that was another piece of evidence I had that I was indeed able to cope and compete in the sciences.

Eleven women worked on independent research projects while they were undergraduates. For some, this was the experience that confirmed their interest and talent. One woman explained:

> The independent work was the most rewarding work I did. Coursework never really fired me up: you're learning basics, but it's not yours. I think this independent work was one of the biggest reasons I went on. I was doing real research, the sort of research I do now.

Thus, hands-on experience conducting research appears to play an important role, testing and focusing a generalized interest in and liking for science.

Only eight of the women we interviewed had not had one or more of these kinds of research exposure above and beyond the lab work required for courses prior to pursuing an advanced degree. Of these eight, three were math majors, two had some limited experience and exposure in summer jobs, one majored in engineering, and one went into dentistry. The eighth discovered that her employment prospects were no better after earning a bachelor's degree in biology than they had been as a high school graduate. She decided to get her master's degree and reports that she "just sort of got into doing research."

Conclusion

We don't know how the innate curiosity or the love of enzymes, bacteria, surgery or computers that many women spoke of during the interviews is created or where it comes from. However, an interest in science or mathematics can be nurtured and developed by: family encouragement and support for educational achievement, a strong instructional background in math and science, exposure to and encouragement from a dedicated teacher, contact with a teacher or professional who truly loves his or--better yet--her work, and hands-on research experience. School counselors can contribute to the effort to develop scientific and mathematical talent by encouraging young women to enroll in elective math and science courses and by introducing them to the range of scientific and technical fields and career options. Perhaps, most of all, young women need

role models: "They have to see that there are people doing these things and leading relatively normal lives, enjoying themselves, and being successful." Their fields and careers require dedication and commitment, our respondents say. But, added one, doesn't any field?

Chapter Six

Higher Education Decisions and Experiences

This chapter examines the college and graduate or professional school experiences of the thirty women we interviewed. It focuses on the educational decision-making process, on the ways in which these women met their educational expenses, and on the experience of being a woman and, for most of these respondents, a minority student in fields where women--especially minority women--are underrepresented among students and professionals. For the most part, these women report that their interests in science, mathematics, or engineering were neither perceived as inappropriate for a women nor discouraged during college. Indeed, the support and encouragement of college faculty members often played an influential role in their decisions to pursue advanced degrees. Although these women tended to research their choice of a graduate or professional program more carefully than their choice of a college, most found adjusting to the demands, expectations, and environment of advanced degree programs was more difficult than the transition from high school to college.

The description of the graduate or professional school experiences of these women discusses the transition to advanced study and the ways in which sexism and racism were manifested at this educational level. We focus on these issues not because they dominated these women's memories of their advanced training or because they prevented them from achieving their educational goals, but because they are related to preventable and sometimes unintentional difficulties that many of our respondents encountered. Furthermore, many of these women remember other women or minority students who did drop out because they didn't have the determination, and the confidence in their ability, or

the emotional support that enabled our respondents to cope with or ignore these problems.

The Undergraduate Years

The only definite educational and occupational plans these women had made during high school were to go to college and, in most cases, to major in science, math, or engineering. A few had dreams of becoming MDs and one hoped to become an astronaut, but only one aspired to earning a PhD. The woman who became an icthyologist describes not only her own situation as an entering college student but that of many other respondents:

> I wasn't sure what I was going to major in the first two years. I was considering biology, biochem, biomath, and physics. I even thought that I might as well go on to medicine, because almost all the other biology majors were premed students. I didn't start learning about other professions until I began working in someone's lab.

Thus, it was during their undergraduate years that most of these women identified the specific fields of study that they specialized in and recognized their need for an advanced degree. Twenty-four entered graduate or professional school immediately after college, although fourteen of them hadn't thought about continuing their education beyond the bachelor's degree until their last year of college. What were their undergraduate experiences like and what influences shaped and guided their educational and occupational choices?

College Choice

All thirty women entered four-year colleges or universities and, as Table 57 shows, three-fifths attended public institutions. The amount of research and thought devoted to selecting a school varied widely from a few

TABLE 57

Type of Undergraduate Institution by Race/Ethnicity

College Type	Black	Chicana	Puerto Rican	White	Total
Public	2	5[a]	6	5	18
Private	5	2	1	4	12

[a]One Chicana attended a Catholic college for one year before transferring to a public university.

young women who had explored a range of alternatives fairly systematically to others who had never thought of applying to any school other than the local public university. The three factors most frequently cited as having influenced college choice were cost or financial aid offer; parental restrictions on whether their daughter could go away to college or if she could go to an out-of-state school; and the institution's academic reputation or orientation toward science and engineering. The relative importance of these factors and the way in which these women went about selecting a school and meeting their college expenses varied among the four groups.

Puerto Ricans. Five of the seven Puerto Rican women enrolled in public schools and lived at home throughout their undergraduate years. Both parental and financial constraints influenced their decisions, but only two considered the idea of going away to school. One woman explained: "In Hispanic families, at least in my family, women didn't move away from home until they were married." Of the two women who did go away to college, one reported that she was able to overcome her parent's objections only because the local public school did not offer her financial aid while a private university did. However, she added, they would never have allowed her to go to an out-of-state college. The other woman attended a campus of the University of Puerto Rico that was not in her hometown. Although she wanted to go to college in the States and still wishes that she had, her parents told her that it was financially impossible.

Paying for a college education posed no particular problem for the four women who attended college in Puerto Rico. Tuition was minimal and their parents paid it. Three of them never worked to help meet their college expenses and the fourth began working her junior year. The two women who

attended public colleges in New York City received state scholarships, lived at home, and worked during both the summer and the school year. The one woman who attended a private college received a financial aid package that included scholarships, loans, and work-study support which she supplemented by working during the summers.

Chicanas. Not one of the Chicanas applied to an out-of-state college and five entered local colleges as freshmen. Again, the two factors that determined their college choices were finances and parental constraints. Of the two who thought of going to out-of-state schools, one abandonned the idea when her father pointed out that he didn't know how the family could pay for her to come home for holidays and the other said her parents would not have allowed her to leave home. These women had and maintain close ties to their families. Three lived at home until they graduated from college, although only one did so at her parents' insistence. A fourth said her parents reluctantly agreed to let her leave home her junior year when she transferred to another campus of the state university. Two attended private colleges, both of which were in their hometowns, and a third went to Catholic school her freshman year.

Three Chicanas received no parental help with their college expenses, although two did live at home, and a fourth received no financial assistance from her parents after she married at the end of her freshman year. Only one woman was able to complete college without working during the school year and taking out a loan: she lived at home and attended a local Catholic school on a scholarship. All seven women worked during the summers to help meet their college costs. The two women who attended private schools received institutional scholarships. Two women had state scholarships and the two youngest women, who entered college in 1971, received federal grants.

Blacks. Although the black women did not come from more affluent families, all seven applied to private colleges and five applied to out-of-state colleges. The availability of financial aid and the amount of aid they were offered were major determinants of their final college choice. Nonetheless, a larger proportion of black women than of any other group attended private schools and four went to out-of-state colleges. Although none of them said that their parents would not have allowed them to leave home, two applied only to local colleges: one lived at home all four years and the other moved to campus after two years of commuting. None of them applied to black colleges and, in fact, all of them attended schools where blacks were seriously underrepresented.

The five women who attended private colleges received financial aid packages that included a scholarship or grant, loans, and, with one exception, work-study support. Two of them reported that the responsibility of meeting their college expenses was entirely up to them, since their single parent could not help them. One did live at home for two years "because I didn't want to take out the world's largest amount in loans." Of the two who attended public colleges, one lived at home and worked to meet her college expenses which she described as very small. The other said her parents paid most of her educational expenses at an out-of-state public university.

Whites. Four of the nine white women considered only local or state colleges, one because her parents said she was too young (age 16) to leave home and the others because their parents said they could not afford to send them to out-of-state schools; all three families had at least two other children in college during some or all of the time that these women were undergraduates. Of these four, two received financial aid offers that enabled

them to attend private schools. The other five women went to out-of-state schools and two of them also enrolled at private colleges.

Although seven of the nine women said that college cost or financial aid offers were factors that influenced their college choice, the white women were less dependent on loans and less likely to report that they had worked during the school year than were the Blacks and Chicanas. Six did receive financial aid which their parents supplemented to varying degrees and a seventh had to take out loans her last two years of college. The two other women said that their parents had paid their college costs, including room and board, at public institutions.

Of these thirty women, one black and three white women attended predominately-male schools, three technical institutes and one Ivy League college that had just begun admitting women. Only one woman chose a women's college: a black woman who went to the of the Seven Sisters. Two women, both Chicanas, attended coed Catholic colleges, although one left after her freshman year. Interestingly, the three women who transferred as undergraduates were residents of the same state and transferred to the same public university: two because they felt it offered a better science education than the schools they had entered as freshmen and the third felt its degree was more prestigious and certainly better known among local employers than that of the public out-of-state school she had attended through her junior year.

The College Experience

These women report that it was certainly not "unusual" for women to major in their field and most said that a substantial proportion of their classmates were women. The two women who majored in a field that attracted few other

women (physics) said that they probably received more encouragement from their professors than their male peers. Twenty-five described one--and usually more--of their professors in their major field as supportive and encouraging. Four of the five who felt that none of their professors had taken a particular interest in them had attended large public universities and had not worked with a professor as a work-study student or on required independent research projects. Thus, they had never gotten to know any of the faculty members. The fifth was a black woman who had attended a predominantly-white private college in the South. She described her undergraduate experience as "basically neutral," and added: "I certainly didn't have an advisor who was interested in what my goals or needs were."

Only two women felt that professors gave their male students more encouragement and attention than women received and both had attended the same public university. One explained:

> Originally, I would have said that I was treated the same as the male undergraduates but, in a roundabout way, I was treated differently. The university was so big that you had to bug the professors to get attention. Men did and so they got more attention and were seen as being serious. I think women really did have to work twice as hard. All the TAs in the labs were men and they encouraged women to team up with men. On joint projects they tended to give higher grades to the man on the team.

A third respondent reports that women were definitely treated differently than men at the technical institute she attended as a member of the first class of women to be admitted. Although the majority of faculty and students had opposed admitting women, she remembers her professors as encouraging. Some did not know how to deal with women, including one who would not call on women in class because, she subsequently discovered, he was afraid they would cry if they got the answer wrong.

Four women did encounter a discouraging advisor or counselor. All four were minority women who aspired to earning an MD. Three were advised that their academic performance wasn't strong enough to meet medical school admissions requirements and the fourth attributes her advisor's discouragement to sexism: "He kept suggesting that I go into nursing or medical technology because they were fields I could always get a job in if I had a husband to support who was going through medical school." Two of these women ignored this advice, although one did decide that she wanted a graduate degree rather than a medical degree. Neither of the other women applied to medical school as undergraduates, a decision they attribute to the lack of encouragement from anyone, particularly these advisors. Instead, they pursued and earned graduate degrees, yet neither felt that she was suited to or would be satisfied with a career in pure research: it was "too isolated." Both applied to medical school in their late twenties and are now realizing their initial career goal of becoming doctors.

We asked the black, Chicano, and mainland Puerto Rican women if they felt they had been treated differently from other students because of their race-ethnicity. Only two Blacks and two Chicanas felt that they had encountered prejudiced professors, but prejudice can be expressed quite subtlely as one explains:

> The professor whose lab I worked in told me later that he hadn't paid me the first summer because he didn't think that I could do it. He expected the Chicano students in his genetics course to do poorly and he never said anything when they did well or gave them individual attention.

Two women, one black and one Chicana, said that, although their professors didn't treat them any differently from other students as far as they could

tell, students did. Both felt isolated and alienated at predominantly-white campuses. Two Chicanas reported that majority students resented the special treatment that minority students who were admitted through affirmative action programs received. Several women remember how upset they felt when another student and, in one instance, professors implied that their grade in a particular course or their acceptance by a prestigious graduate or professional school was due to their sex or race rather than the merit of their work.

In general, these women report that the men who were majoring in their fields either accepted or welcomed their presence. They described those men who resented women majors as "insecure about their own abilities." Students in other fields of study tended to assume that women science, math, or engineering majors were "brains," an assumption that made many of our respondents uncomfortable. Several said they certainly never chose to tell people what their major was in social situations if they weren't asked. They weren't uncomfortable with the idea that women could be intelligent, they were uncomfortable because they didn't believe that they were necessarily smarter and because they didn't want to be treated as if they were somehow different.

The most frequently reported extracurricular involvement was membership in the club or society related to their major field: over one-third said they had been active in the biology, premed, chemistry, or engineering student association. Other extracurricular activities that were mentioned with some frequency included team sports (8 women), social organizations (7), band or choral groups (5), minority students associations (4 Blacks and 1 Chicana), student government (4), and volunteer work through a service organization (4). Although participation in extracurricular activites reflects personality, it

also seemed to be related to residential status and college size: students who lived at home and attended larger schools tended to report the fewest extracurricular activities.

The only regrets these women expressed about their undergraduate education had to do with missed opportunities. Some wished that they had taken more courses outside their major field rather than specializing as early as they had. An engineer wishes that she had been less cautious as an undergraduate: she would have graduated with a stronger background if she had enrolled in science courses for science majors instead of those geared toward non-science majors. Two women are chagrined to remember the lack of iniative they had shown as undergraduates: neither sought out opportunities to work on faculty research projects or got involved in the lab. One said:

> When I took my lab courses, I just went in and did what I had to do quickly and got out. It never dawned on me that it was something that I'd be applying later on. Now I regret that I didn't get more out of it for myself.

In part because of their lack of research experience, both women discovered their interest in their current field only after leaving college headed in a different occupational direction. A third woman reported that she was almost bounced out of graduate school during her first year because of her poor undergraduate research background.

Post-College Plans

Four-fifths of these women completed college in four years, two finished somewhat sooner, three took somewhat longer, and one was a full-time student for almost eight years. Although only four women entered college with plans to earn an advanced degree, 25 applied to graduate and/or professional

school their senior year. Two of the oldest interviewees pointed out that the idea of women planning for and having careers didn't come along until after they had completed college. One explained:

> I decided I would go to graduate school my senior year. I had known that I wanted to go to college and be a scientist, but I think younger women have it thought out better...those of us who started earlier just kind of kept going.

Most had, of course, identified a particular field that they liked and wanted to learn more about, although a number of those who applied to graduate schools were still undecided about which subfield of physics or the biological sciences they would choose as their specialization. Four of the biological science majors were still uncertain about whether to apply to medical or graduate school as late as their last year in college. All four ultimately chose graduate school, although two applied to medical school and would have gone had they been accepted. In retrospect, both feel graduate school was the better choice. One explained: "I just think I'm happier doing this than I would be practicing medicine."

The three factors that were most frequently cited as having led to their decision to continue their education were: strong encouragement from undergraduate faculty members; the realization that none of the jobs they might be able to get with a bachelor's degree were interesting to them or that an advanced degree was a prerequisite for the kind of work they wanted to do; and the fact that most of their peers were applying to graduate or professional schools. The relative importance of these three factors varied: a Puerto Rican woman says she would never have had the confidence to apply to graduate schools in the States had her biochemistry professor not almost insisted that she do so and then guided and pushed her through the selection and application

process. A black woman who received no particular encouragement from her undergraduate professors says she began thinking about a graduate degree her senior year after she started looking around for full-time employment and discovered "a bachelor's wasn't much better than a high school diploma." In most cases, all three factors came into play, as ther remarks of a chemist illustrate:

> I started thinking about going to graduate school my junior year in college when it became apparent that you've got to think about what you're going to do after your senior year. A lot of people I ran around with were going to graduate school. It was a definite decision by fall of my senior year. My advisor encouraged me to go to grad school and I knew from technician jobs that I didn't want to be a technician. I wanted to think. I went for a master's and stayed for a PhD. I never really made a conscious decision to have a science career, I just rolled with the punches.

Of the twenty women who have earned or are working toward a PhD, seven aspired to a terminal master's when they began graduate school. Only one woman lowered her degree aspirations after starting graduate work, an engineer who says she realized after her first quarter that she couldn't last five years in graduate school. She never applied for a transfer into the PhD program as she had intended to do and left after completing a master's.

Twenty-four women did begin work toward advanced degrees immediately after completing college, two worked for one year before going to graduate school, and two worked for four years before returning to school. Of the two engineers who do not hold graduate degrees, one began work toward a master's through an in-house program sponsored by her employer but decided, after switching jobs, that she could pick up what she needed through in-house

seminars. The second was just beginning her second year of employment but was planning to return to school for a master's degree as soon as her finances permitted.

Graduate and Professional Study

Few women described their experiences in graduate or professional school as positively as they spoke of their undergraduate education. Almost all of the women who pursued PhDs remember times they were worn out, emotionally and physically, or discouraged because their research wasn't going well and they thought about quitting, although not one had considered dropping out of college. Many report that the demands on time and energy that advanced degree programs make of all students, regardless of gender, were compounded by sexism, a feeling of isolation or loneliness in an environment where there were few other women or minorities, and, for some black women, racism. However, individual experiences varied widely from women who report strong support and encouragement to women who were discouraged and unhappy but who simply refused to give up. A black PhD said: "I don't think I ever thought about not quitting. It was miserable. I didn't quit because I was Black and I thought, if I quit, it was because they wanted me to quit because I was Black."

Institutional Choice

Three-fourths of these women applied to at least two institutions. They identified the programs they applied to by reading brochures and catalogs, by asking undergraduate professors for advice and recommendations, and, in some cases, by examining the research literature to find out where the important research in their field was being conducted and who was conducting it. Two

women attended a guest lecture during their senior year of college where they learned about the program that they subsequently attended. Four women said that the deciding factor in their choice of a graduate program was the reputation of a particular scientist under whose supervision they hoped to pursue their research. Six women applied to only one institution: Four to the same university that they had attended as an undergraduate and two to an institution that had agreed to accept their application although the deadline had passed. In fact, three applicants got into graduate school as the result of personal intercession on their behalf: the two late applicants and a third woman who decided where she wanted to go after applications were no longer being accepted.

Eight women attended two institutions in the course of their graduate careers, including all three who got into graduate school as a result of personal intercession on their behalf and three of the four women who began their graduate work at their undergraduate institution. Another two women had attended two institutions, earning a graduate degree at one university and pursuing a medical degree at another.

While their reasons for entering a second university reflect a number of considerations, our data do indicate that the women who were more systematic in their initial selection of a graduate program tended to remain at the university they entered and to complete their degrees faster. Of the twenty women who pursued PhDs, thirteen did all their graduate work at one institution and two made a carefully coordinated transfer to a second university early in their graduate career. They earned their doctorates in 3 1/2 - 5 1/2 years and average time to degree was 4.8 years. Five said they had completed their PhDs faster than their fellow students and only two said that it took them slightly longer. Five women earned a master's degree at one institution

before entering a PhD program at another university. They spent from 6-9 years in graduate school and average time to degree was 7.2 years. The latter group includes four of the seven women who entered graduate school with no definite plans to continue after completing a master's degree. It also includes the only women who interrupted their graduate work: two were out of school for one academic year and one worked for 4 1/2 years before entering a PhD program. One women says she finished faster than anyone had ever finished in her PhD program (5 years) but explains that, because she took one year off after earning an MS and changed universities, she had had to take all the courses she took during her two years as a master's student over again. Thus, these women tend to describe their time-to-degree as average or better, except for the one who spent a total of nine years in graduate school, "longer than anyone else."

Finances

Availability, amount, and type of financial aid was certainly a concern and sometimes influenced the final choice between two institutions that otherwise seemed equally attractive. However, institutional cost was never cited as having affected our respondents' decisions about where to apply for advanced study and only one woman said that she had not attended her first-choice institution because it did not offer her financial aid. Several pointed out that they could not have continued their education without financial assistance.

The only women who had to asssume responsibility for a substantial portion of their educational expenses pursued medical degrees. With the exception of one medical student who received a public health service scholarship that she must "repay" tnrough three years of public health service upon completion of her training, these women received financial aid packages comprised of about equal amounts of scholarship and loan support.

Three women who held master's degrees in technical fields reported that their employers had underwritten their graduate education. Two worked while pursuing a master's at a local university and the third was granted a one-year leave of absence to pursue her degree at an out-of-state university. Her employer paid her educational fees and provided a stipend to meet her personal expenses.

The twenty-two remaining women who attended graduate school (including the engineer who originally planned to earn a PhD and the two women who later entered medical school) had either received a financial aid offer with their letter of acceptance or been awarded a Ford Foundation fellowship for graduate study. Seventeen entered graduate school with institutional or departmental support in the form of stipends, teaching assistantships, research assistantships, fellowships, tuition waivers, and federally-supported traineeships or predoctoral fellowships. Of these seventeen, three applied for and were awarded Ford fellowships during their first year of graduate study. Five women had applied for and received Ford fellowships during their last year of college. Not one of these eight fellows ever interrupted her education, although one was the engineer who decided she wanted a terminal master's degree. A ninth woman who had interrupted her education after earning a master's learned about the Ford fellowship program when she decided to return to school for her PhD. She applied despite personal reservations about participating in a program for which only minorities were eligible:

> It was the first time I had ever applied as a minority and I had never been in any program where I was classified as a minority student. I always thought it would just be better to do it on my grades and whatever, but my husband and I were both applying to graduate school. We knew we couldn't both be in school at the same time unless I got a fellowship.

Another Chicana also remembered that she had had "huge moral qualms" about applying for a Ford fellowship: "I was against programs that excluded

people out of principle." She finally decided that "some Chicanos were going to get it and I might as well be one of them." The only other woman for whom receiving support from a program intended to increase minority enrollments was an issue had received an institutional opportunity award as a master's student. She had graduated phi beta kappa from the institution and resented the fact that all the black students received opportunity awards while white students were offered teaching fellowships: "What was wrong with our getting up and teaching too?"

The women whose families were in no position to supplement their fellowship or institutional support often reported that finances had been a persistent concern. One explained:

> It was hard to live on $350 a month in [an urban area]. Middle-class kids can do it, but poor kids have a rough time. They don't have parents who are gong to buy them a car or get them new shoes when they come home for Christmas or send them a check for their birthday.

Another woman says that, if she had realized how expensive it was to live in the city she moved to in order to pursue a PhD, she might have chosen another university.

Four women said they had assumed loans or taken a job in order to meet their expenses. A white woman whose husband was also a PhD student and who had a child said they had had to take out several loans and her husband had worked during vacations. The other three were black women from low-income families that had not been able to help them with their undergraduate expenses. One took out a loan prior to receiving a Ford fellowship and also held part-time work-study jobs during most of her graduate career. One took out loans as a master's student and taught at a community college while she earned her PhD. The third worked off-and-on while she pursued her master's but received

adequate support for her doctoral study. The latter two did apply for and receive dissertation-year grants from the Ford Foundation.

Institutional Location

Some women did report that institutional location or distance from home was a consideration in deciding where to continue their education. Several women who had attended a local or state school as undergraduates said that one of their criteria for selecting a graduate program was that it be in some other region of the country. On the other hand, several women who had earned their bachelor's or master's degrees at out-of-state institutions said they had applied to institutions where they would be nearer to their families.

All seven of the Puerto Rican women attended institutions on the East coast, although three did apply to and receive acceptances from universities in other parts of the country. Only one said that location was a decisive factor in her institutional choice and she chose a school in the Bronx where her family lived over one in Manhattan. Although four of the six Chicanas who pursued advanced degrees attended universities in California, all four had applied to schools in other parts of the country and only two were Californians. The institutional choices of black and white respondents reflect no regional concentrations.

Institutions Attended

These women attended some of the most prestigious institutions in the country, as Table 58 shows. Many minority women said that the encouragement of some individual to "shoot for the stars" was critical to their decision to apply to such highly respected universities. The Puerto Rican women whose

TABLE 58

Institutions Interview Sample Members Attended as Graduate or Professional Students

Baylor University College of Medicine
Boston University[a]
Brown University
City University of New York
Columbia University
Fairleigh Dickinson University, Rutherford Campus
Florida State University[a]
George Washington University
Johns Hopkins University
Massachusetts Institute of Technology
Pennsylvania State University College of Medicine, Milton S. Hershey Medical Center
Stanford University
Temple University[a]
Texas A & M University
Texas Southern University[a]
University of Arizona
University of California, Berkeley
University of California, Los Angeles
University of Colorado, Boulder[a]
University of Dayton[a]
University of Florida
University of Houston
University of Illinois
University of Iowa
University of Michigan[a]
University of North Carolina
University of Puerto Rico, Mayaguez Campus[b]
University of Southern California
Yale University
Yeshiva University, Albert Einstein College of Medicine

[a]Awarded no degree higher than a master's to any member of the interview sample.

[b]No degree awarded.

undergraduate mentor had to convince her to apply to schools in the States which the young woman thought were "way too high" explains:

> I think all minorities have this idea that no matter how good you are, your preparation isn't good enough to compete. So rather than meet the challenge, you go the easy way. For me, it was key people at the right times saying "you can."

She experienced no academic problems during the transition to one of the nation's ranking universities and was told, when she completed her PhD, that her advisor had described her to a colleague as one of his two best students.

Only three women said they would choose a different university if they had their educational decisions to make over again. One was a Puerto Rican woman who chose a school where she felt safer living away from home for the first time and where she had been warmly received on a visit rather than a larger, more prestigious university that offered her more financial aid. Today, she says she would choose "the best graduate school I could get into." The second was a black woman who attended a university that enrolled very few black students and was located in a community that had virtually no black population. She says that she would never again choose an institution where she had no social or cultural support system. The third was a white woman who says she succumbed to the glamour of a "name" institution without investigating faculty attitudes toward women students. She never felt welcome at the university and had considerable difficulty finding a faculty member who would agree to work with her. Judging from the reports of other women who attended the same institution, this attitude toward women was department-specific: it was not a problem that women in the biological sciences experienced.

The Transition to Advanced Study

The transition to graduate or professional school went smoothly for most of the women we interviewed. Only three felt they were academically under-

prepared for the demands of a graduate program. Their difficulties appeared to stem from their lack of undergraduate research and lab experience. One explained:

> I didn't know how you looked things up in journals. I didn't realize that you had to read some of the journals. I didn't know how to write a research paper or how to do research or statistics or any of that--I was so lacking in graduate school skills. All my advisor could and did do was be very supportive, but I could hardly expect him to spoon-feed me...and you're always caught between asking a question because you need the information and not asking it because you don't want them to know that you don't know.

In addition to trying to remediate their academic deficiencies, all three were also adjusting to being away from home for the first time.

A fourth woman reported that her academic adjustment was complicated by the fact that she found herself worrying about grades for the first time in her life:

> The most disheartening part of going to graduate school for me was that I lost a bit of my freedom to try things out. You had to be more productive. I could feel myself becoming reluctant to try things out because they might not work rather than trying them out because they might work.

She, too, found herself away from home for the first time and described herself as "shell-shocked" by the transition from a small private college to a large state university.

Two black PhDs said they had experienced a kind of cultural shock during their graduate careers. One had moved from a small local college to a large institution in the northeast where people seemed cold and aloof in contrast to the outgoing Southerners she was familiar with. The second had earned her master's at a black university in the South where she received strong support and encouragement. She describes her move to a PhD program as "a difficult transition from a warm environment, emotionally and physically, to a very cold

one." A third, who had grown up and attended college in the South, vividly remembers arriving at a Northeastern graduate school: She was greeted by a man with a deep Southern accent who had an enormous Confederate flag hung in his office and who asked if he could help the "little lady." It was an intimidating and somewhat misleading introduction to the East coast and to a school that she subsequently discovered was very supportive and strongly committed to minority education.

Encountering Sexism

Sexism appears to be much more pervasive at the graduate and professional level than at the undergraduate level. About half of our respondents encountered biases against women as they began to pursue advanced degrees. Usually this was the first time they had been discouraged or treated differently from their male peers because they were women. Sexism was expressed in a variety of attitudes, assumptions, and behaviors: the attitude that women simply didn't belong in the field or profession; the belief that women just didn't have what it takes, in terms of talent or ability, to succeed in the field; avoidance by professors who were obviously uncomfortable with women and who gave male students more attention and guidance; and exclusion from opportunities to do field work or from informal social events. Our respondents discovered no satisfactory responses to being asked if they seriously intended to pursue a career, to being spoken to condescendingly, or to being informed that there wasn't a "decent woman" in their field.

In some cases, individual bias was obvious and the respondent was able to avoid working with the person(s) who expressed it. For example, one woman made an appointment with a professor she had been told had to be on her committee.

> The first thing he told me was: "The Germans have done your research so it's useless." And he was incorrect. The second thing he told me was that women were made for going into the kitchen and bearing children, and for taking care of a family. I told him "thanks but no thanks" and that was the end of him as far as my committee was concerned. If I had taken his advice, I would have quit around October of my first year in grad school.

Another woman changed departments after her first semester because she felt she didn't need to disprove all the negative assumptions about women that the faculty members obviously subscribed to.

In other cases, bias was subtle and the respondent recognized what was going on only as the evidence accrued and, often, only after first going through a period of self-examination because she thought that something was wrong with her. One woman said she worried that she was becoming paranoid until people around her began to comment on her advisor's behavior:

> He would ask [a male student] to look over a manuscript and give him feedback right in front of me, but he would never ask me. I gave good journal presentations and, after two or three professors had complimented me, he would walk in and say: "That was a little too fast." When [the male student] and I were choosing our committees for our oral comprehensive exams, he told [the man]: "I'm not worried about you. You've got it cold!" But he didn't ask me about mine so I followed him into his office and said: "I want to schedule mine for such-and-such a date." He said: "Okay, but make sure another time later in November is available." I asked why and he said: "Well, just in case you fail, you can take it over again."

She did extremely well on the exam and, from then on, her advisor sought her opinion and treated her as well as the male student, but she says that she will never forget those first two years.

She was able to identify two factors that contributed to the problems she experienced those first two years. One was the fact that her advisor had never had a female graduate student before. As increasing numbers of women pursue advanced degrees in traditionally male fields, the likelihood that their

professors will have known other women who have successfully completed degrees in the field also increases. Our respondents' reports suggest that it can be as difficult to overcome the reservations of a professor whose previous women students have dropped out of school as it is to be a faculty member's first woman student. Women who have entered advanced degree programs more recently than our respondents are more likely to have been preceded by sufficient numbers of women who successfully completed their degree requirements to demonstrate that one cannot use gender to accurately predict scientific promise and commitment. Thus, we would hope that fewer and fewer women entering advanced degree programs will find themselves confronted by the burden of disproving stereotypic assumptions about women.

The second factor that she identified as having contributed to her problems with her advisor was her own behavior: She had been brought up to be modest about her accomplishments and to be quiet and respectful toward persons of authority and people who were older than herself. Two other Hispanic women, who also attended highly competitive graduate programs, reported that their own reticence had been a barrier to their early progress. They received less attention from the faculty and often found themselves observing rather than participating in the activities and exchange that lead to faculty sponsorship of their students' careers. Faculty members need to recognize that there may be a discrepancy between the behavior they expect and reward and the behavior that women have been brought up to consider appropriate. Furthermore, entering students should be informed about the faculty's standards and expectations for student behavior. Unarticulated faculty expectations can create unnecessary barriers. For example, one of the women didn't discover that her

advisor's policy was to help those students who helped themselves until her self-confidence had been severely eroded by the advisor's apparent preference for those students who were good at self-promotion. Had she known that her advisor was waiting for her to show her willingness to fight for what she wanted, she could have avoided considerable personal unhappiness and developed a strong, supportive relationship with her advisor far sooner than she did.

Encountering Racism

The Hispanic women rarely felt that their ethnicity had affected the way they were perceived or treated by their professors or student peers. The most notable exception was a Chicana who entered a graduate program in a city with a large Hispanic population:

> There was a feeling--although it was only expressed by a couple of people--that the reason I had gotten in was because I was Mexican-American, that I'd gotten in on a special program, and that I wasn't smart enough or as smart.

Another Chicana who attended graduate school in the northeast described it as "the freest environment I had ever been in" and explained: "For the first time, I felt as if I had a chance to make it or break it solely on my academic merits." A Puerto Rican woman who said that people had treated her "special" in a positive way because she was from the island added: "I don't think that would have happened if I'd studied in New York where there's a less exotic aura." The Puerto Rican women who were graduates of Island universities did go to graduate programs that were farther from New York than those attended by the mainland Puerto Ricans. One of the mainland respondents thinks she didn't have to deal with bias against Puerto Ricans because her last name doesn't sound Hispanic and few people knew she was Puerto Rican. While the other two

did not feel they had been treated differently because they were Puerto Rican, both said that their close friends were other minority students who provided peer support and that they had been active in efforts to increase minority representation at their respective campuses.

In contrast to the experience of the Hispanic women, four of the seven black women enccuntered racism in the course of their graduate careers. Of the three who did not remember encountering bias, one is not physically identifiable as Black, one attended an institution that was demonstrably committed to minority education, and the third, who attended medical school, recalls bias against women entering the profession but not toward minorities.

Like sexism, racism can be expressed covertly or overtly. Two of the black women said that the racism they experienced was always subtle--an "aura of patronization," comments that they overheard, "little problems that didn't have to happen," and remarks that implied that they were beneficiaries of special admissions efforts to increase minority enrollments. Racism is also similar to sexism in that it is often difficult to understand what's going on and why, as one respondent explained: "You can tell when people have trouble relating to you, but then you wonder if it's because of your personality or because you're a women or because you're black." The two other women had dealt with a professor who was so evidently racist that they had no difficulty identifying the source of their problem with this individual. One was assigned to a graduate advisor whose research goal was to prove the genetic inferiority of blacks. Ignoring the evidence of her academic proficiency, he insisted that she enroll in remedial courses and set out to improve her cultural background which he also assumed was deficient. Unable to imagine how long it would take her to earn a PhD under his supervision or if it was even possible

to do so, she transferred to another department.

The interview data indicate that racism can create barriers to graduate school success and, certainly, that it can create an environment where students feel prejudged and unwelcome. The data also suggest that Blacks are much more likely to encounter prejudice than Hispanics, perhaps because Chicano and Puerto Rican populations have concentrated in specific regions of the country and prejudice is correspondingly regionally specific.

Conclusion

Almost all of the women we spoke with felt that, as undergraduates, they were accepted on their individual academic merit and accorded the same respect and opportunities as their male peers. As they proceeded to advanced degree programs, many encountered individuals who seemed skeptical about their promise as scientists and their professional commitment. As long as women and minorities remain underrepresented among graduate students and professionals in scientific and technical fields, many will feel pressured to prove their competence and their career commitment by working harder than the average student or professional. One woman who remembers occasional teasing about her "double advantage" as a minority women says: "I worked very hard never to be seen as an exception or a special case."

These women attribute their achievements in part to "luck" not out of modesty or because they feel they are undeserved, but because they know that there are a substantial number of equally talented women and minorities who could also have become scientists, engineers, mathematicians, or doctors if only they had received some of the critical opportunities, information, and encouragement that they had received. Indeed, these women feel they worked

hard--often twice as hard as their male peers--to earn every degree, every scholarship or fellowship, and every job offer they have received. But some one or more people along the way--in high school, college, or graduate school--provided the advice, support, and encouragement that they needed to raise or realize their educational and occupational aspirations.

Chapter Seven

Choosing and Pursuing Careers

These thirty women grew up in the 1950s and 1960s, when the terms "career woman" and "professional woman" usually referred to teachers, nurses, and executive secretaries. They were in college or graduate school before the women's movement gained national visibility, before anyone began to count the number of women engineers, doctors, research scientists, college professors, or corporate executives and ask why women were severely underrepresented in these fields, before people began to question whether women's concentration in low-status, poorly paid jobs didn't represent a tremendous waste of talent both for individual women and for society at large. When did these women who grew up without the benefit of programs designed to foster career awareness begin to think about careers? How did they go about finding jobs in traditionally male fields? Do they feel that affirmative action affected their job search and its income? How do they feel about their work and what career plans and goals have they established for the future?

Developing Career Awareness

To the extent that these women thought about the future during their childhood and teenage years, they expected to work when they grew up. Two-thirds said their mother worked and so they assumed that they, too, would work. Three of the ten women whose mothers were homemakers said their father had strongly encouraged them to enter a traditionally male profession (law, medicine, and veterinary medicine, respectively) and a fourth said: "My father drummed into me that I had to be able to support myself. He felt very strongly that you should have a career, some sort of profession that you

could call your own." The only woman who said she expected to work but only until she married came from an upper-middle-class family, had a non-working mother, and said her father discouraged her from pursuing a graduate degree because he thought that she was avoiding facing reality.

Early career interests reflect one's exposure to occupational alternatives. The most visible science-related career is medicine and almost half (14) of our respondents said that they had once planned to become a doctor. One-third of the minority women but none of the white women said that they had identified a specific occupational goal prior to high school. It is interesting to look at where these early aspirations came from: one woman wanted to be an astronaut (she was so fascinated by the televised coverage of the space program that her father called her "sputnik"), one planned to become an engineer (a career her older brother was pursuing at the time); one who had read biographies of Marie Curie and Pasteur had set her sights on becoming "a scientist"; two planned to become doctors (one hoped to be able to help her parents who were often ill, the other was influenced by a popular television show and, as the image of its doctor hero wore thin, she renounced this goal and informed her family that she would probably become a biologist instead); and two thought they would teach, the only professional occupation they were aware of for women in Puerto Rico.

Just over half (16) of our respondents said they knew, by the time they entered college, that they wanted to pursue a scientific or technical career and three said they reached this decision during their freshman year. While most said this decision had simply evolved out of their interest in science or math, three of the four women who had participated in special science programs during high school traced their career commitment to this experience. However, except for those women who planned to become doctors or engineers, these women had no specific occupational goal in mind nor did they necessarily

know what scientific field most interested them. One explains:

> Already when I graduated from high school, my aspiration was to become a scientist. I had enjoyed my experiences in the lab. At that point, I had no career goal or plan to get a PhD. I was going to college and I wanted to be a scientist and exactly what that entailed was not clear at all.

Eight said their decision to pursue a scientific or technical career was made during college. They simply hadn't thought about careers and about what they would do after they earned a bachelor's degree until then. Three respondents said they had enrolled in graduate school without ever consciously making a career decision. It was not until after they had taken what seemed like the logical next step in the educational process that they began to think about possible occupational outcomes.

As these women fulfilled their undergraduate coursework requirements and worked on research projects, their experiences reinforced, focused, or led them to redefine their earlier interests and goals. By the end of her sophomore year, the woman who knew she wanted to become a scientist when she entered college knew that she wanted to be a chemist: "Physics didn't interest me that much and biology didn't involve as much of the kind of lab work that I wanted and enjoyed." Other women who were attracted to a general field, like biology, discovered more specific interests in botany, genetics, icthyology, and biochemistry. Some revised their career plans as they discovered new interests. For example, one woman who entered college planning to go on to medical school and become a pathologist subsequently decided to become a chemist which meant that she had to take physics: "When I took physics, I decided chemists didn't really know what went on in the atom, physicists did. I decided to be a physicist."

Just as medicine was the most obvious early career choice for our respondents, those who decided to pursue graduate degrees tended to aspire

to careers as college teachers. Of the fifteen who entered graduate school planning to earn a PhD, fourteen expected to become university professors. One explained:

> My only idea, in terms of a career goal, was that when I finished my doctorate I would be a professor at a university. This was what I thought there was: you taught and worked in the lab. And that was a perfectly fine thing. I thought that if you went to work in industry, they would dictate what you would do and where and how.

The fifteenth woman said she got most of her information on careers from reading brochures about graduate programs:

> Teaching was the career they talked about most--teaching and research. At that time, my senior year in college, I had been involved in research with one of the graduate school professors and I thought that was very interesting and I would enjoy that kind of challenging situation. So my idea was to get a degree, return to Puerto Rico, and do research through the university or [a research center].

Seven women entered graduate school planning to earn a terminal master's degree: two hoped to teach at the college level, two were interested in pursuing research careers, and three said they had had no career goal in mind when they began their graduate work. All seven went on to pursue PhDs and all considered the possibility of a university teaching career at some point in graduate school.

As graduate students, these women confirmed or disconfirmed their interest in teaching and research and expanded their knowledge of career options. Of the eighteen women who were teaching assistants in the course of their graduate careers, eight found that they really enjoyed teaching and working with students. One says this was a major factor in her decision to return to graduate school for a PhD: "I still want to teach, preferably at a four-year college where you have science and nonscience majors. I like working with kids who think they hate science and showing them how it relates to what they do every day." Much as they enjoyed teaching, two of these

women found academic research "too isolated" and subsequently entered medical school. However, one did complete her PhD "because I really enjoyed teaching and wanted to take advantage of the future possibility that I might want to go into academic medicine." On the other hand, five women said their experience as teaching assistants confirmed their interest in research careers that were unencumbered by teaching responsibilities.

Our respondents' interest in nonacademic jobs increased during graduate school as they learned more about opportunities in other settings, as they met people who worked in industry, federal labs, and museums, and as they became clearer about what kind of job would best suit their interests. Three women said that conditions in the academic labor market prompted their decision to find employment elsewhere. They had watched postdocs who applied for faculty positions year after year without success, the annual turnover of young assistant professors at the institutions where they were doing their graduate work, and the problems that even tenured professors were facing in the competition for increasingly scarce research funds. A fourth woman attributes her growing interest in working in the private sector to her disillusionment with the pettiness and politics of academic science. Whatever career paths these women have taken or plan to take, they have chosen jobs that interest them and that offer opportunities for continued professional growth.

As our respondents' knowledge of scientific and technical careers expanded, their career goals changed and became more focused. As they moved through the educational system, they chose particular fields and tested out their interest in teaching and research. As they proceed along the career paths they have chosen, they continue to examine their alternatives and to establish new goals.

Entering the Labor Market

With the exception of four of the youngest respondents who entered college in 1971 and who were still completing or had just finished their training, all of our respondents had worked. In looking at how they went about finding jobs and what kinds of positions they sought and found, it is important to distinguish among those who sought employment after earning a baccalaureate, a master's degree, or a medical degree or doctorate.

Bachelor's Degree Job Seekers

Seven women entered the labor market after earning a bachelor's degree: three engineering majors, three math majors, and one geology major.* Six had already begun to think about pursuing advanced degrees: two wanted a break from school, two would have gone on had they had the funds to pay for further education, and two sought and found jobs that enabled them to pursue their master's while working. Two of the math majors became secondary school teachers: one taught high school math for four years before returning to graduate school, the other taught part-time for a year and then accepted a job as statistics officer at the university where she was taking graduate courses.

Two of the remaining five women never actively sought jobs. One was an engineer who had worked for several companies as an undergraduate; her last employer invited her to remain with the company. The other was the geology major who was offered a job in the petroleum industry by a division geologist she met through a friend's father during Christmas vacation of her senior year in college. Reluctant as she was to go into industry and to return to her hometown, the lack of alternatives and an offer for "more money than I believed I would ever make" helped her to overcome her reservations. She was

*An eighth woman whose applications to veterinary school and medical school were not accepted spent one year working as a waitress before enrolling in graduate school.

also strongly encouraged by one of her professors who felt that every geologist should work in the petroleum industry and that she had to stay in the field if she hoped to enter graduate school later on.

Three women actively sought first jobs in traditionally male fields: two engineers who began their job search through college placement offices and a math major who wanted to become an engineer. One engineer did interview widely but admits "in my heart, I really wanted to go home." She looked for a position with a company that offered a program where she could work and go to graduate school. When a company in her hometown offered her a job that allowed her to attend school full-time, she jumped at the offer. The second engineer accompanied her boyfriend to a city halfway across the country and then flooded the job market with resumes. She received two offers and accepted the closest one since she didn't have a car. The aspiring engineer took advantage of a trip to a neighboring state to visit a lab (a prime government contractor) whose work she had heard about in her college courses. She had her name added to the lab's campus recruitment list. Returning home, she interviewed with companies doing work in energy fields and, just as she was about to follow her parents' advice and look for a job in insurance, the recruiter interviewed her:

> He decided he liked me and was impressed with my background even though I didn't have the engineering background they usually look for. He did everything in his power to get me an interview at the lab. He encouraged me and spoke up for me.

She was offered a job through the lab's affirmative action program that gave her release time, first to take undergraduate engineering courses at the local university and then to attend one of the nation's top-ranked engineering programs.

Of these seven women, two still work for their first employer, two completed higher degrees before seeking another position, and three changed

jobs after gaining work experience but no additional educational credentials. The math major who worked while pursuing her master's interviewed with a NASA campus recruiter: "Working for NASA was always my dream since I was ten years old. I thought this was just a dream, that it was impossible." When a job offer came through, she accepted it and moved to the mainland, abandoning her partially-written master's thesis. The other two job changers actively sought new positions. After over two years with her first employer, the geologist wanted to find a position with a company that would provide training in geophysics. She launched a brief but intensive local job search: "I interviewed everybody and pulled all my connections and found out every job that was available." She also worked with a head-hunter. The engineer who had accompanied her boyfriend to one city returned to her home state one year later when he was accepted by a medical school there. Anxious to have a job, she accepted an offer before moving back: the commute which seemed reasonable from several thousand miles away was too much and the work wasn't challenging. After three months, she found another position through a college classmate. Although she established contacts with head-hunters and interviewed every few months "to keep in practice," she remained with the company for four years. When the company laid her off due to financial difficulties, she quickly found a new position through her head-hunter contacts.

Of the six women who held one or more traditionally male jobs, five feel that affirmative action played a positive role in their search for employment, especially in finding their first job. One of the engineers explains:

> It forces employers to really consider you. I was still a very feminine character and I dressed up in frilly little dresses. If there hadn't been affirmative action, I don't think they would have taken me seriously.

After accepting her first job, the geologist learned that the man who hired her had had to go to the company's corporate headquarters and fight "because I was

a woman and because they never hired people without a master's which I didn't have. But the biggest problem was that I was a woman." Not surprisingly, the math major who wanted to become an engineer feels that she wouldn't be where she is today without affirmative action:

> I don't think that I would have had the stamina to pursue a master's without the support and encouragement I got from [her employer]. The affirmative action program got me in the door. They never would have hired me otherwise.

Once hired, these women found they had to prove that, although affirmative action might have helped them get the job, they were as qualified to do the work as any other employee. Occasionally, they had to overcome resentment from coworkers who hadn't had similar "advantages." One engineer said:

> I think the people who are not part of the affirmative action pool feel negatively affected or think that maybe you are not qualified for the job and you're just being hired because you are a minority or a woman.

Hard work, competent performance, and patience overcame skepticism and earned them the respect of their colleagues even in such male bastions as tracking stations and oil rigs.

In sum, the women who sought employment after earning a bachelor's degree had majored either in fields that provided job-relevant training (engineering and geology) or math, a field with no obvious connection to any job other than teaching. They tended to look for jobs locally and only two relocated to accept a job offer. The three engineers and the geologist held a total of eight jobs, all in the private sector. Two found their first job through personal contacts, one through her college placement office, and one by circulating her resume among local employers. Professional contacts and head-hunters were the key sources of assistance in finding subsequent jobs. The three math majors held a total of four jobs, three in the public sector and one with a prime government contractor. Two women found nontraditional

jobs by interviewing with campus recruiters, though one woman initiated the interview. Of the six women who held one or more nontraditional jobs, five feel that affirmative action helped them in their job search, principally by "opening doors" that led to their first job in a traditionally male field.

Master's Degree Job Seekers

Five women sought their first job after receiving a master's degree and an engineer who had worked while earning her master's degree subsequently changed jobs. Two biology majors and a physicist had entered graduate school planning to earn a terminal master's degree and, although all three were considering going on for a PhD, they felt it was time for a break before making a final decision. Two women had planned to earn PhDs, one in biology and one in engineering, but left graduate school after earning a master's degree.

All three women with a master's in biology found jobs in education: one taught biology as a Peace Corps volunteer, one taught high school science at a Catholic girls' school, and one worked as a tutor, prehealth counselor, and finally as director of a program for science-oriented minority undergraduates sponsored by a university affirmative action program. The high school science teacher had left home for the first time when she went to graduate school: "I thought with a master's I could come back and teach in one of the smaller colleges or the junior college." She was quickly disabused of this notion: "People wrote back saying they'd gotten PhDs who were willing to take paycuts for these positions... and suggesting I go on for a PhD." Nonetheless, she was tired of school and, anxious to go home, she refused a job offer from a lab at a university in the state where she had done her graduate work. She found her first job through her brother who met someone who told him about the high school opening. Similarly, the woman who worked for the affirmative action program found her job through personal contacts. She had worked for the program as a

volunteer and as a summer employee while she was in graduate school.

The high school science teacher was the only one of these three women who changed jobs before resuming her education. After six months of teaching, she applied for local summer jobs everywhere that had an electronmicroscope: "I knew I wasn't getting any of my research techniques." She found a position as a lab technician at a medical school and was invited to stay on in the fall. Unable to accept because she had signed a teaching contract, she arranged to continue working in the lab ten hours a week. When the school year ended, she returned to the lab and remained there for three years. During the last two years, she took classes with the medical students and, encouraged and pushed to go on by the people she was working with, decided to enter a PhD program.

The engineer who worked in industry while earning her master's became disillusioned with the private sector: "I wanted something more out of working." Suspecting that perhaps teaching would be more satisfying, she moved across the country to accept a faculty position at an historically black college. Within less than a year, she found she missed industry which now seemed a better choice. She was approached by a corporate recruiter, interviewed, and returned to industry. She accepted the offer because the work sounded interesting, the salary offer was very good, and the position was in her hometown: "I wanted to come home but not to just any job, so I saw it as an answer to a prayer."

The engineer who entered the labor market after earning her master's degree found a summer job in industry during graduate school through the campus placement center. At the end of summer, the corporation's career placement officer told her that the company wanted her to work for them as soon as she earned her degree. She decided to accept the offer and never really sought a job. She believes that affirmative action influenced her offer in

in that she came in at a higher salary than most of the men who were hired at the same time: "I think they were afraid of losing a prospective candidate."

Thus, the only woman who found her first job by conducting a job search was the physicist. Recently married to a fellow graduate student, she moved to his hometown. She found a position in medical research at a hospital through an employment agency: "I was essentially a glorified lab assistant, although I was making good money." She discovered that "to do any kind of research on the level I wanted, I was going to have to get the PhD." The next academic year she and her husband returned to graduate school.

In summary, of the five women who entered the labor market for the first time after earning a master's degree, four held degrees in the life or physical sciences (in contrast with one of the seven bachelor's-level job seekers) and the fifth was an engineer who had originally planned to pursue a college teaching career. Including a sixth woman who began working after receiving her bachelor's degree in engineering and changed jobs after earning her master's, these women held a total of eight jobs, six in the public sector. Both women who worked in the private sector were engineers and both were recruited for these positions. The only woman who relocated to accept a job offer was an engineer. As with the women who began working after receiving a baccalaureate, these women looked for their first job locally or were offered local jobs before they began seeking employment. Again, we find that personal and past work contacts were particularly helpful in finding a first job; one woman found her first job indirectly through a campus placement office; and one used an employment agency. Of the four women who subsequently returned to school, three said they were encouraged to do so by people they met through their jobs and by a growing understanding that they needed a higher degree to realize their occupational aspirations and interests.

Doctorate and MD Job Seekers

Thirteen women completed doctorates and one finished all of her medical training before ever entering the labor force. Of the six women who returned to school after working for one to four years, three were still students at the time of the interview and three had reentered the labor market with doctorates. Eleven of the sixteen PhDs hold degrees in the biological sciences, four in the physical sciences, and one in mathematics. Two accepted their first job as early as 1974, and two as recently as 1980.

The academic career path. Nine women, all of whom had earned PhDs in the life sciences, said that college teaching was still their career goal at the end of graduate school. Since postdoc experience is generally a prerequisite for a faculty position in the sciences, six never considered looking for anything but a postdoc. Two applied for both faculty openings and postdocs and one applied for postdocs only after a survey of the job market in her field failed to identify any curator or faculty openings. In looking for positions, four of these nine women had to take their spouse's plans or job commitment into consideration. Five women located postdocs pretty much on their own by identifying and approaching scientists whose labs they wanted to work in. One of the five reports that her department chairman did introduce her to his professional contacts in the city where she was conducting her job search, but none of the other four received such assistance. One of these women turned down the postdoc offer she had worked so hard to get. She was the only married woman who considered relocating on her own and would have done so had she not been mugged shortly before she was to move. Unable to face a strange city alone, she accepted a postdoc offer from a faculty member at the local university. Two women learned about their postdocs from their graduate advisors who sponsored them for the positions. Only two women found their first job by going through more formal channels: one applied for site-specific

postdoctoral fellowships that required formal research proposals and the other responded to ads in Science and job announcements posted in her department. This last woman received and accepted a position as an assistant professor. A tenth woman, the MD, was also offered a faculty position. She said that she had always had "a lot of educational plans but beyond that I hadn't thought about what I wanted to do." As the end of her residency neared, she sought her department chairman's advice about what she should do next. To her surprise, he suggested she stay on as an instructor while she made up her mind. She attributes this offer, which she accepted, to a very good report from a surpervising physician. Eight of these ten women relocated: two left their home state for the first time and one returned, having restricted her job search to that state. Six of the eight postdocs were at a university, one was in a government lab, and one was at a museum.

At the time of the interviews, four women were still completing their first postdoc, two had begun a second postdoc, one had moved into a research staff position in a government lab, and one had found a faculty position at the medical school where she did her postdoc. The two women who started their careers as faculty members had both been promoted. Of the four women who changed jobs, three found their second job through personal contacts. Acting on the department chairman's recommendation, one woman moved on to a second postdoc at the university where she did her first postdoc. Although she had planned to move, her plans were contingent on her husband's success in finding a new job and his search yielded no interesting offers. The other woman who took a second postdoc learned of the position she accepted at a government lab from a graduate school friend. She had turned down research staff offers at two government labs because she still wanted an academic career. She had also refused "a fantastic opportunity" to set up and manage a university research facility because she was offered a staff position with no assurances that it

could lead to a faculty position: "Staff positions are easy for women to get into, but hard to get out of." The postdoc who did move into a faculty job attributes her offer to the intervention and advocacy of an assistant professor in a related field: "It was the first time a woman stepped in and made a tremendous impact on my career. She knew my work and suggested to her chairman that they consider creating a position for me." The woman approached both her own chairman and the postdoc's chairman who pooled their resources to find the funds and space necessary to support the position. The fourth job changer and her spouse decided to move back to the east coast, choosing a city where they both would have job prospects. Having geographically defined the area in which she would seek a job, she set out to find a research position. She found a job in a government lab without help from her postdoc advisor who was upset by her refusal to accept a job in another location that he wanted her to take.

Informal channels were the route to jobs in the academic labor market for most of these women. Some approached prospective employers on their own initiative, others were introduced to prospective employers or recommended for jobs by professional contacts they had made as graduate students or post-docs and, in one instance, as a resident physician. Only two women thought that affirmative action might have influenced the outcome of their job search and both had found employment by going through more formal channels. The woman who found a faculty position by responding to advertised openings says she really does think that affirmative action helped: "The schools that I applied to all seemed strongly interested in me because I was an affirmative action candidate." The other who had written research proposals for post-doctoral support observed that her employer's office of fellowships and grants was staffed by women who might have encouraged the appointment of women.

However, the other respondents felt affirmative action exerted little or no influence in the academic labor market.

The nonacademic career path. By the time they earned their PhDs, four women had lost interest in teaching, two were reevaluating their interest in academic careers, and one who had strong prospects for either a teaching or a research job in Puerto Rico had her career plans completely disrupted by marriage to someone who worked on the mainland and who, furthermore, could not pursue his career on the island. This last woman and one of the women who was reassessing her interest in teaching held degrees in the life sciences, four were physical scientists, and one was a mathematician. The three women who had not ruled out the possibility of an academic career did go through the preliminary motions: one lined up a postdoc and two applied for faculty positions. Each one also applied for one nonacademic job that led to an offer they accepted: a research staff position in the private sector, a job as curator of publications, and an application to become an astronaut brought one woman the offer of her own research lab at NASA. The woman who entered the corporate world attributes her job offer to the sponsorship of a graduate school dean who pointed her out to the company as a promising young scientist. The woman who became a curator had been doing some part-time editing and research work at the organization that hired her.

Of the four women who were no longer interested in teaching, three wanted to pursue research careers and the fourth--the mathematician--said that she set out with an open mind to see what she could find in the local labor market. It is interesting to note that the two married women both completed their degrees a year before their spouse did and accepted interim teaching positions at the institution where they completed their graduate work. Both physicists looked for postdocs, using professional contacts to identify openings. One said she also responded to ads in Physics Today and used employment

services at professional meetings. A scientist at a private research corporation that funded postdocs saw her name in a professional association registry and contacted her with a postdoc offer. It was, she said, her only offer and she accepted. The other physicist said that she and her husband, who was in a more specialized field, began their job search by identifying organizations that might be able to offer both of them jobs. Their best prospects outside of industry, where they preferred not to work, appeared to be with a national lab. After refusing an offer from their first-choice lab because her husband's application was turned down, she accepted a postdoc at another lab that offered her husband a staff position. The chemist, who was interested in "industrial-type research," was also married to a man whose field offered fewer relocation possibilities. However, this couple conducted independent job searches, investigating local prospects for their spouse on interviewing trips. Although she was offered two jobs with companies she identified through the university career placement center, she received the offer she accepted with a prime government contractor after completing a job application that her husband brought back from a successful interview trip. The mathematician also used her graduate school's career placement services in conducting her job search. She narrowed her choice to a corporation and a university-affiliated research organization. She chose the research organization in part because she did not want to do defense-related work, but reports that she almost accepted the corporate offer because she wasn't sure that her PhD was from a sufficiently prestigious university. A friend finally convinced her that she would be foolish to refuse the job she preferred because she was intimidated by the organization's reputation.

Thus, four of the women who took jobs outside of academe accepted research staff positions, two took postdocs, and one became a curator. Four

were employed by the federal government directly or indirectly, two were in the private sector, and one worked for a botanical garden. At the time of the interviews, two women were with a second employer, two had assumed a different position with their first employer, and three were still in their first job. Three of the four job changers were married: one was a postdoc who moved into a staff position with her postdoc employer, one moved to the lab where her husband was employed, and one had taken a sabbatical from her job in the lab to work as a corporate recruiter. The only woman who relocated was unmarried when her first postdoc ended. She responded to ads and used her professional association's employment services to identify research openings in the private sector and at national labs in the western states.

Two women were certain that affirmative action had not played any role in their job search. One said:

> Everyone assumed that women in science had it made, but I never found that to be the case. A couple of places wanted my resume to show the affirmative action office that they had tried, but they didn't offer me a job.

Two women who work as researchers in government labs would prefer to think that their job offers were based solely on their academic qualifications and that affirmative action was not a consideration. However, one says she's found that "the possibility of just going in as an anonymous candidate and being judged by the regular standards gets thrown out the window as soon as it's found out that I'm female and Black." The other admits that she "wouldn't be surprised if they were attracted by an opportunity to get a person with good credentials who was also a woman and Puerto Rican." Four women said that they did feel that affirmative action had influenced the outcome of their job search, primarily by "opening doors" to interviews. The woman who was essentially recruited by a corporation feels that affirmative

action provided the impetus that led the company to seek her out and invite her to visit their research center. The mathematician believes affirmative action helped her get interviews with some companies that would otherwise have ignored her application.

Summary. Sixteen women sought jobs after earning a PhD, thirteen for the first time, and a seventeenth entered the labor force after completing her medical training. Nine of the eleven women with doctorates in the life sciences entered the academic career path, accepting postdocs or faculty positions, while all five women with PhDs in the physical sciences or math sought research positions. All seven women who accepted positions outside of academe formally applied for jobs, while eight of the ten women in the academic career path either approached or were introduced to the individual who offered them the job that they accepted. Only women who had formally applied for jobs believed or suspected that affirmative action had affected their job search.

Women who held doctorates were far more likely to seek and accept jobs that required them to relocate than were women who sought work after earning a bachelor's or master's degree. Thirteen moved to accept their first job: the three who did their graduate work in their home state moved out of state and only two women returned to their home state after doing their graduate work elsewhere. Of the remaining four women, two accepted a position at the university where they had earned their highest degree, one remained in the same city, and the fourth sought work in the city she had moved to after getting married and before completing her PhD. Doctoral degree-holders were also much more likely to be married than job seekers with a bachelor's or master's degree. Married women reported that their spouse's plans or job commitments were a major consideration in their search for employment. This is clearly

reflected in the job-seeking behavior of the eight women who had changed jobs since entering the labor force: the two unmarried women were the only ones who conducted a geographically unrestricted job search.

Work Experiences

Most of the women we interviewed spoke about their jobs in very positive terms. They liked their work, they feel that their coworkers and supervisors accept them as competent professionals, and they believe that they have as much responsibility as their male peers. There are exceptions and job experiences do differ by employment sector and type of employment. However, the similarities of postdoc experiences transcend differences in postdoctoral setting. Ten women held a total of twelve postdocs and most describe their experience as productive and satisfying, professionally and personally. The most notable exception is the one woman who did her postdoctoral research at the university where she earned her doctorate because her husband worked there. She feels that she wasted her time in a lab where no one else worked during her first postdoc, and said her second postdoc was equally isolated and lacking in collegial support until she managed to establish a collaborative arrangement with someone in another lab. A second woman said she did "interesting work and accomplished some things" as a postdoc, but had a tension-fraught relationship with her advisor who exhibited little faith in the abilities of his female students and postdocs. She had limited her search for a postdoc to the university where her husband wanted to do his graduate work. None of the other postdocs restricted their job search to one institution and all of these women describe their advisor as supportive and say that there was a great deal of collegial interaction in the lab.

Educational Institutions

Fourteen women had held at least one full-time position at a university, one had worked at a museum and one at a botanical garden. Three women worked at a university before going on for a higher degree. Two enjoyed their jobs and said the encouragement and support of people they met through their work was critical to their decision to seek a higher degree. The third held an administrative job that she found routine and boring once mastered. Women who held postdocs in academic settings were particularly pleased with their opportunities for continued learning and their freedom to pursue research in a supportive environment.

Six women taught at a university, although two did so only because they were waiting for their husband to complete his graduate work and a third returned to industry after one year. One of the women who accepted an interim teaching position remembers that "they didn't think a women could do it." When the man who was offered the position turned it down, they changed the teaching responsibilities and offered her the job at a lower salary. The three women who remained in academe were assistant professors at the time of the interviews. All reported having had to take an assertive role in monitoring their career advancement. One said that, unlike her male peers, she had had to personally negotiate her promotion and salary increases: "Men take care of and fight for each other. I have not had that kind of mentoring." A second women successfully filed a grievance for retroactive back pay when the university hired two men with less teaching experience at a higher rank and salary a year after she was hired. Two women felt they had a heavier load of committee and public service work than their male peers. One explained: "Because I'm the only woman so-and-so around, I tend to get asked to do a lot of different things, not so much by the department but by the school and

outside groups, and it's hard to limit myself and say no." Both women regret that they don't have more time for their own research. The third woman had been able to concentrate on her research for two years thanks to a faculty development award that freed her from some of her teaching responsibilities. All three women like teaching and interacting with students, enjoy working in an academic setting, and are actively involved in efforts to improve the representation of minorities and women in their field and at their institution. Indeed, one has assumed administrative responsibility for looking after the affairs of nontraditional students and actively recruits prospective female and minority students.

The curator also enjoys her work very much, particularly her professional independence, and only regrets having so little time for her own research. Although she once sought a faculty position and does teach through her employer's adult education program, she has no interest in seeking a faculty position, nor does she feel she would be competitive after almost four years outside of the academic world.

Government Labs

Ten women had worked in a federal lab, a national lab, for a prime government contractor, or for a university-affiliated lab that did government research. They describe their work as challenging and interesting, and especially enjoy the problem-solving aspects of their jobs. Regardless of their work setting, these women felt their experience, in terms of job responsibilities and treatment on the job, was similar to that of their male peers. One woman says she does wonder "if men have to defend and explain their work as much" and another observes that being a woman brings added visibility to her work including any mistakes that she makes.

Several women did feel that they had had to stand up for themselves and prove their competence to gain the professional respect of their colleagues in situations where a man would not have had to do so. One of these women says she has been assisted by a supervisor who has become a mentor: his confidence in her abilities and faith in her potential has "carried over" and helped her gain the respect of her coworkers. She feels her professional experience has differed from that of her male peers in that she has had to learn how to deal with stress and conflict in a professional setting: "I'm highly emotional and I don't like to argue. I've always regarded the fact that my emotions were on the surface and that I reacted with them as a special quality." She quickly learned, however, that being so emotionally reactive was neither an appropriate nor an effective way to resolve work-related disagreements.

The Private Sector

Six women had held at least one job in the private sector and a seventh did her postdoc at a private research organization. Women appear to encounter more difficulty gaining professional acceptance in the business world than in academe or government labs. One woman who moved into a private sector research lab after earning her PhD says:

> You feel that once you get your degree and enter the profession, things are going to be smooth sailing. It turns out that the further you go along, the more and more difficult it becomes to establish your credibility, to be treated as a peer, to be respected for your ideas, and to be respected the same way.

She found she often had to remind her colleagues that she was a member of the research group and expected to be treated as one: "A lot of times, particularly in a research environment, projects, ideas, and inventions come about when people interact at a certain level socially and being a woman can exclude you

from a great deal of that interaction." Her frustration contributed to her decision to take an administrative sabbatical after four years in the lab.

Four of these women were engineers who enjoyed their work and felt their responsibilities were equivalent to those of their male peers. Two feel that they have established their technical credibility once and for all, one has only been working for a year and is still struggling to do so, and one, who works for a counseling firm, says: "What bothers me most in my professional experience is feeling that, because I'm a women, I always have to prove myself before I'm accepted." Like the PhD, one woman feels cut off from the male communication network and is concerned about how this will affect her professional advancement. She has adopted an assertive strategy of making appointments with high-level managers to discuss her career goals and seek information and advice. A second woman says that her immediate supervisor had adopted her as his protege and is pushing her ahead. She is extremely pleased with her job and remarked: "The executive vice-president is a woman and it may be coincidental but this is the first company [of four] where I've felt no prejudice against women." In fact, this woman seriously considered bringing a sex discrimination suit against one of her previous employers who laid her off after four years while retaining the services of a man who had been hired for a comparable position six months earlier.

Corporate attitudes apparently do affect individual experiences. The woman who had worked in the petroleum industry reports that her first employer made a policy decision "before I even arrived that I would be treated just the way the men were treated. And they did, as far as I could tell." However, she was less fortunate when she changed jobs. Despite warnings from a former professor and over the strenuous objections of the head-hunter she was working with--"She said the company I was considering had a horrible reputation for

dealing with women"--she accepted the offer because:

> I was different. Those were other women. I'd had a really good interview and I didn't feel it would be that way. I'd had some terrible interviews with companies that said flat out: "We don't want girls" --it's always "girls"--or "We already have a girl."

She quickly learned that she wasn't different and after several incidents where she was assigned to clerical work that none of the male trainees were asked to perform, she left the company.

Summary

These women's reports reflect a high level of job satisfaction, although the postdocs are anxious to move on to more permanent jobs. What they like most about their jobs, regardless of their employment sector, are opportunities for continued learning and professional development, independence, the fact that their work is interesting and challenging, and interacting with colleagues whom they like and respect. Women who work in academic settings particularly like the interaction with students and their freedom to pursue independent research. Researchers who work in government labs and for prime government contractors find their work interesting and challenging; they enjoy applying their skills to a research problem; and several spoke of the satisfaction they derive from working on "important" projects that are advancing scientific knowledge. Most of the private sector employees were engineers who especially liked the problem-solving aspects of their work; they sought jobs that provided them with opportunities for professional growth. No employment setting was free of sexism, but women in the private sector were most likely to feel that they had encountered problems gaining the respect and acceptance of their colleagues. Women often feel cut off from the male communication network and mentoring system and, thus, feel that they must assume a more assertive role than their male peers in seeking out information and positioning themselves to advance in their careers. Interestingly, none of the minority women felt that

racism had been a problem in their professional career, although sexism had been.

Career Goals

Women who were working generally expected to remain and advance in the career path they chose after completing their formal education. Those who were still completing their training had seriously thought about their career futures. Only one of the eight postdocs who originally planned to pursue an academic career has lost interest in her earlier career goal. She was always more interested in research than in teaching and, at the end of her postdoc, she took a research staff position in a government lab: "I still thought I wanted to work in a lab pretty much forever." She finds her work interesting but underpaid and says she would like to move into an administrative position in a private sector or government lab or research center: "I'd like a hybrid position that allows me to stay in close contact with what's going on in the lab as well as getting my foot into administration." Her loss of interest in academe stems in part from her feeling that the most exciting work that's going on in her field is the applied research that's being done in the private sector and in research institutes: "For the longest time there's been snobbery between basic and applied research, but now applied seems to be coming into its own."

The belief that basic research is "better" or a more noble pursuit is reflected in the comments of women who aspire to academic careers, few of whom have ever ventured out of academe. One asserts that "industry is a cop-out because they don't care about pure science," while others feel that working in industry would be "too limiting" or "restricted." One woman who took a postdoc in a federal lab reports that she was really surprised to find that she

liked working there. While they perceive academe as a freer environment in which to pursue research, most also want to teach and enjoy interacting with students. Several say they feel a real commitment to educating people about how important science is and how much fun it can be. A medical student who holds a PhD says she wants to go into academic medicine: "I feel there's a great need for minorities in the educational system, not only as role models but to do active things like recruit and retain students." The five postdocs and the three students who aspire to academic careers point out that the scarcity of faculty positions in many of their fields will certainly affect their career decisions. Two of the three assistant professors plan to continue teaching and hope to expand the scope of their already impressive research activities, and the third, the MD, describes herself as "leaning toward staying in academic medicine." What she regrets about academic medicine is not having patients of her own, but she says her ideal job would be an administrative position in the department of her medical specialization at a medical school.

In addition to the woman who left the academic career path and moved into a government research lab, seven women have managerial aspirations. They want to be less involved in the technical side of engineering, the routine lab work, or the manipulation and analysis of data and more responsible for project management. The assumption of more administrative responsibility is the clear path to career advancement in their job settings. Three women dream of opening their own business once they have acquired the technical skills and experience they need. Of these eleven women, the only one with a degree in the life sciences is the woman who defected from the academic career path.

Four of the eight remaining women hold or are about to earn PhDs in the biological sciences, three are in medical fields, and one is an engineer. One PhD is a curator and, beyond devoting more time to research, forsees no career changes; a second PhD hopes to become a curator and teach as an adjunct faculty member at a local university. The two MDs plan to work as clinicians serving low-income and minority patients. The dentist who says she consciously chose dentistry over medicine because she wanted to have a family "and raise my children myself," plans to go into private practice and hopes some day to have an office in her home. Three women are less certain about their career future. The engineer plans to spend several more years with her current employer: "By then I should have accomplished a very good piece of work that I could stand on and go anywhere from." A woman who was about to complete her PhD admitted: "My career plan now doesn't go beyond doing my postdoc. I don't know if I want to teach, do research, or both." While she expected to have no difficulty finding a postdoc in her field, she pointed out that other job prospects, especially in teaching, were not very good. The third woman, who works as a researcher in a government lab, says:

> I always have a dream of eventually return to Puerto Rico when I'm a little bit mature in my science. I wanted to get more experience because it's a little isolated there, but I feel an obligation to return and I think eventually we will.

Of the four women who grew up on the island, she is the only one who still expresses interest in returning there to work.

With few exceptions, women with degrees in the life sciences appear to gravitate toward academic careers, while those with degrees in the physical sciences, mathematics, and engineering have moved into research and technical staff positions in government labs and the private sector. Of the five women in medical fields, two plan to pursue careers in academic medicine, two

plan to work as practitioners providing medical care to underserved populations, and one plans to go into private practice. In talking about their personal goals, women in the academic career path tend to mention making a contribution to science, educating people about how exciting and fun science is, and helping to train the coming generations of scientists. Women in research and technical positions aspired to assuming greater responsibility for project management. They feel that their technical expertise and the decisionmaking and problem-solving skills they have developed in approaching research and technical tasks make them obvious candidates for administrative positions in government labs, research institutes, corporations, and even in their own consulting firms.

Conclusion

There is something fortuitous and haphazard about the ways in which these women arrived at a career focus for their interests in science and math. Few had parents they could turn to for information and advice about careers in scientific and technical fields and some say their parents still don't understand what they do. They received almost no career guidance during high school. Indeed, about half the minority women who went to high school in the States were told by teachers or counselors that their aspirations were unrealistically high or inappropriate. They kept taking courses in science and math because they enjoyed these subjects and, as they proceeded through the educational system, their knowledge of scientific and technical fields and careers steadily expanded. Nonetheless, most women pursued their academic interests without a very clear sense of how they could use their education in the labor force or of what their occupational alternatives were.

Women in the physical sciences, math, and engineering were more likely to seek work before earning their highest degree than were biological scientists and women with medical degrees: six of the twelve physical scientists, mathematicians, and engineers began working before receiving their highest degree and a seventh, who recently accepted a job after earning her bachelor's, is planning to pursue a graduate degree in the near future, while only three of the eighteen women in the biological sciences and medical fields (17 percent) interrupted their education. Five of the six women who entered the labor market with a bachelor's or master's degree in engineering or the physical sciences moved into technical staff positions in the private sector. Five of the six women who entered the labor market with a bachelor's in math or a master's in biology report that their first job was teaching. When we look at the career choices and plans of all thirty women, we find a very similar pattern: the biological scientists and medical professionals tend to move into academic careers and public service, the physical scientists, mathematicians, and engineers go into research and technical staff positions in government labs and the private sector. These choices appear to reflect personality, whether or not one enjoys and derives satisfaction from teaching and interacting with students, the extent to which basic and applied research are valued in one's field, and how much one knows about job opportunities in different work settings.

Chapter Eight

Conclusion and Recommendations

Not one of the thirty women we interviewed expressed dissatisfaction or regret about her decision to pursue a scientific or technical career. The mathematician said she felt "a certain amount of curiosity about whether or not I could have gotten a PhD in psychology," a field she discovered she had an interest in and talent for during her last semester of graduate school. Three women said they might choose different specializations if they had their educational choices to make over again. Interestingly, all three held PhDs in the physical sciences: a chemist who feels she would be better suited, temperamentally, for a career in engineering or computer science; a nuclear physicist with an interest in cancer research who has "toyed around" with the idea of adding an MD to her credentials at several points in her career; and a chemist who thinks that an MD rather than or in addition to her PhD would enable her to have a more direct impact on people's lives.

We also asked each woman if she would recommend a career in her particular field to young women in high school and college.* Eleven wholeheartedly recommended their field without qualification: four engineers, an MD, a geneticist, a microbiologist, a pharmacologist, a botanist, a geologist, and a data analyst. For the most part, these are fields with obvious practical applications in the current labor market. For example, the pharmacologist points out the "flexibility" that a PhD in pharmacology provides: "You can go to work for drug companies, you can go into research, administration, or sales, and there are opportunities in medical schools." Two women said that while they wouldn't not recommend their field, they would recommend another

*This question was omitted in the telephone interview with the dentist and in a personal interview with a medical student.

field more highly: a chemist who feels one's earning power and job mobility would be greater in engineering and computer fields, and a PhD in anatomy who said she would recommend an MD since that could lead to research or teaching but "if things got hard, they could always practice medicine." Of the remaining women, fourteen recommended their field with qualifications and one urged young women "to take as many technically-oriented courses as they can--all the math and all the science they can" to avoid prematurely foreclosing their options.

The "qualified" recommendations were endorsements of the field followed by additional comments to the effect that young women needed to make a decision that was informed by an understanding of the dedication and commitment required, of the job situation in the field, or of their salary prospects. A nuclear physicist and a molecular biologist said they would hesitate to recommend their fields to anyone whose career goal was a faculty position. They feel there are interesting and exciting job opportunities in other settings. Two biochemists and a botanist are less optimistic about employment prospects in their fields. As one says: "From a personal satisfaction standpoint, yes, I would recommend it. From a realistic perspective on the career market, I don't know." All three women had entered graduate school with an academic career as their goal: one has chosen another career path at least temporarily, one continues to apply for faculty positions as she nears the end of her second postdoc, and the third anticipates two or three postdocs before she reaches her goal. Seven respondents emphasized that, as personally satisfying as they found their work to be, it required commitment, hard work and long hours and that persons interested in entering their fields should examine the strength of their interest or commitment before making a decision. A surgeon explains:

> You have to love surgery because it does require a lot of time, energy, and effort. It takes time that one

> might want to spend with family. You have to be committed to it. . . . . I love what I am doing. With all the complaints that I have sometimes about not having enough time, I'd rather be doing this than anything else.

An ichthyologist who hopes to find a position as a museum curator observes: "It's something you have to love. There are few practical day-to-day applications." Four respondents noted that a PhD in science was probably not a wise choice for someone whose goals included making a lot of money; but, added one, "As far as being a satisfying, worthwhile experience, it really is and I really enjoy it." Finally, three PhDs specifically warned young women that they should be prepared to face biases against women in science: "There's still a lot we have to ignore or overcome or fight."

Barriers to Scientific and Technical Career Choices

"Sciences aren't harder than any other field," said one respondent. "I wish there were more women," remarked another when we asked if she would recommend her field to young women. A third responded to the question by saying: "I think women are great engineers." Our respondents believe that young women must be provided with active encouragement and direction in order to overcome the barriers that prevent them from seeing scientific and technical fields as "a viable alternative where they can succeed." The most frequently mentioned explanations of why science, math, and engineering attract so few young women have to do with their image and reputation, beginning with the self-perpetuating nature of occupational segregation by sex. "The basic problem," explains a botanist," is that we associate things with a particular gender whether it's true or not." She went on to observe:

> There's this attitude that math and science are for men and the humanities and secretarial work are for females. I think that kind of attitude is very damaging because it blocks your options before you even notice them as options. You just have to look beyond these attitudes that would limit your world for you.

Furthermore, our respondents agree that efforts to expand girls' perceptions of their career alternatives must begin early: "By high school, it's almost too late and, once you're in college, you can't major in science without the high school background."

Poor teaching and inadequate science and math programs were identified as factors contributing to the low level of interest in scientific and technical fields. A physicist says she's convinced that "cultural discouragement" can be overcome "if the motivation is there." However, she adds, the motivation comes from discovering that science is interesting and fun, a lesson she feels the public schools are doing a poor job of getting across to their students. A biochemist reports:

> In junior high, I had virtually no science and what little I had was so boring that I hated every minute of it. The quality of science and math teaching in the lower level schools has to be improved to attract people.

Like so many of the women we interviewed, she had one outstanding high school teacher: "I always looked up to my high school biology teacher because she was so good . . . she always encouraged us."

A desire for social acceptance discourages girls from excelling in science and math. An engineer who often speaks to junior high and high school students about careers in mathematics fields observes: "Peer pressure focuses on dating and appearance. Boys won't look at you if you're smart." A young scientist remembers that she and her girlfriend were often the only two girls in advanced science and math classes and reports: "We chummed around with the guys because we were in their trig and physics classes, but they didn't ask us out." Like several other respondents, she describes herself as lucky to have had a girlfriend who shared her "oddball" status and says that having a woman high school math teacher also helped. A doctoral student observed: "I think a lot of girls are afraid to exhibit their talents because a lot of men don't

like that. I still want guys to like me and I feel nervous if they feel threatened by me." She went on to emphasize the importance of introducing both sexes to professional women: "Both boys and girls need to see that women can be doctors, lawyers, professors, stockbrokers or whatever. Those boys need to see that because they're talking to their girlfriends and becoming fathers and raising daughters."

Several respondents pointed out that many young women still see their choice as marriage and family or a career. One explains: "Even when young women want to go into these areas, they don't see how they can combine that with marriage and children." The Mexican-American and Puerto Rican women felt these concerns and pressures were a particular problem for young women of their cultural background. A Chicana engineer explains: "I was raised with the belief that, as soon as I reached a certain age, I should get married and have kids." Her family never encouraged her to go to college and she feels her experience was typical of that of many young Hispanic women, although she feels attitudes have begun to change recently. A Puerto Rican scientist reports that her sister was forbidden to apply to medical school by her boyfriend:

> About 90 percent of the Puerto Rican males would not tolerate their wife working and being strongly committed to her career. That would be forsaking the family. The technical part is just not feminine. Even if a woman has the intelligence, the ability, the perseverance, and everything that it takes to be successful in a technical career, it takes so much dedication that it's assumed you can't have a family too.

A Chicana scientist who agrees that science and math aren't seen as feminine "especially by older Mexican parents," feels an equally strong factor is "the social consciousness" of young women: "Science or math are not a way to go in and help the people or, at least, that's the way people look at it. They go into social work or bilingual education." Or, our data suggest, if they

have a strong orientation toward science, they go into medical fields. The two Chicanas we interviewed who decided to enter medical school after earning graduate degrees were strongly committed to improving the quality of medical services in Mexican-American communities and the cultural sensitivity of the professionals providing these services.

In sum, the flow of young women into scientific and technical fields is restricted by the perception of science, math, and engineering as "male" fields that are too difficult for women, the generally uninspiring quality of science and math instruction in elementary and secondary schools, the lack of peer support for excelling in science and math and the importance of social acceptance to young women, and the belief that a career in these fields would be too demanding to combine with marriage and a family. These barriers are reflected in the underrepresentation of women among entering college freshmen expressing an interest in scientific and technical fields documented in the trends analysis, and by the higher science attrition rates of women as undergraduates and in the transition to advanced degree programs documented in the longitudinal analysis.

The interview sample suggests that women who have persisted and succeeded in these fields are independent, determined, and highly talented. A recent study by the National Research Council found:

> On the average, as measured by college grades and high school test scores, women scientists at receipt of the doctorate show evidence of higher academic ability than men and, in recent years, have completed their PhDs as fast or faster than men. This finding supports the inference that women may have been more highly selected. (1979, p. xiii)

Our data indicate that this selection process begins very early and, although many women are deselected or select themselves out of the pool of prospective scientists, mathematicians, and engineers before they ever get to college, their ranks are further and disproportionately reduced during college, the

transition to advanced study, and in graduate school.

Recommendations

What can we do to encourage more young women to consider careers in scientific and technical fields? The three recommendations most frequently offered by the women we interviewed were: introduce them to role models; provide information about career opportunities and about what professionals in various fields do on the job; and improve their precollegiate preparation in math and science.

Role Models

"I think you need to be in contact with people who are excited about science and who encourage you. My life happens to have been filled with people like that and I think that made all the difference in the world," said one young scientist explaining her decision to pursue a science career. As children and teenagers, our interview respondents looked to teachers and older women students for corroboration that it was okay to be interested in and good at science and math and for encouragement. They looked to their mothers, aunts, and family friends for evidence that they could pursue a career and have a family too. As they grew up, they turned to professors, to people they worked with on research projects, and to the visible professionals in their field for examples of successful women, for encouragement, and to identify individuals after whom they could model their professional career and personal life.

While men can be and were cited as role models, young women need to know that women can and do succeed in scientific and technical fields, that they like their work, and that they have pursued careers without sacrificing their other interests, including marriage and children. Exposure to women scientists,

mathematicians, engineers, and medical professionals also helps to dispel misconceptions that only men succeed in these fields or that those women who do pursue these careers are unattractive, dull, and pedantic. We can think of no better role models than the women we interviewed and are encouraged by the fact that many of them do make an effort to participate in programs designed to expand girls' career awareness.

We also urge men to assume greater responsiblity for encouraging girls to pursue scientific and technical careers and to adopt women students as proteges. In 1981, there were only 68 women chemical engineers who were full-time college employees in the country, 79 astronomers, 111 mechanical engineers, 161 oceanographers, and 490 physicists (NSF data reported in "Fact-File", 1982). Obviously, few young women who aspire to careers in these and a number of other fields will have an opportunity to work with a woman advisor. We hope that men will encourage and support their career development.

Career Guidance

"The educational system needs to help people avoid making career mistakes by defining opportunities early and by letting students know what professionals do," says one interview respondent. The women we interviewed received little career guidance and a substantial proportion of the minority women were actively discouraged by counselors and teachers who felt their goals were unrealistic or inappropriate, given their gender, their race or ethnicity, and their socioeconomic background. Casserly observes that many counselors lack an appreciation for "the depth of a superior student's interests and aspirations," have little or no background in the physical sciences, and often try to talk girls out of enrolling in industrial arts and shop courses: ". . .science frightens many professional guidance counselors; and the long studies and training required to achieve professional status in such

fields seem even longer to them" (1980, p. 157). Our respondents point out that even counselors who try to encourage women with nontraditional interests and aspirations often know very little about career opportunities in scientific and technical fields.

Efforts are being made to reduce conscious and unconscious counselor bias, to expand their knowledge of career alternatives, to publish nonsexist textbooks and guidance materials, and to introduce career education into the elementary and secondary schools. We strongly support these efforts and urge teachers, counselors, and administrators to bring women in nontraditional fields to the schools as guest speakers at school assemblies and career days and to take students on field trips where they can see scientists, mathematicians, and engineers in the work place. If specifically asked, many employers can arrange to introduce visiting students to a woman professional although it might not occur to them to do so otherwise.

Precollegiate Education

"If you want to go into science, start taking science and math courses as early as possible, even grade school. You can only help yourself by doing that," says a scientist who explains that even if you decide not to go into science you will have acquired knowledge and problem-solving skills. Our respondents are convinced that many young women foreclose their career options by avoiding science and math courses before they even know about the range of exciting careers that require a solid background in these subjects. The longitudinal analysis shows that strong preparation in math is especially critical to undergraduate success in scientific and technical fields. The interview respondents would also urge young women to enroll in industrial arts and shop courses to develop their mechanical skills and self-confidence, to gain experience building things and taking things apart, to become familiar

with technical apparatus and with simply getting their hands dirty.

Parents, teachers, and counselors must encourage girls to take science and math and they must not accept or excuse poorer performance from girls than they would expect from boys. However, unless these courses are taught by good teachers, they will have little impact on students' interests and aspirations. Outstanding teachers, many of whom held advanced degrees, made a tremendous impact on our interview respondents. These teachers were knowledgeable and excited about the subjects they taught, good at communicating their own enthusiasm, demanding, and encouraging. Today, we face severe national shortages of math, science, vocational and technical education teachers, and there is concern about a drop in teacher quality as well. The trends analysis documented a substantial decline in interest in teaching careers among science-oriented college freshmen. The fact that starting salaries and opportunities for advancement are greater in industry is certainly a major contributing factor to the teacher shortage, but as a mathematics education professor observes:

> The whole image of public education is so bad that no one wants to go into the field. Industry can take off the cream of the crop. Teachers used to beget teachers, but the parents who are teachers are so fed up they are advising their children against it. (in Savage, 1982, p. 15)

The one interview respondent who taught in the public schools for several years was urged to get her teaching credential by her parents, both of whom were teachers, but reports: "Teaching today requires so much and more than I had."

We must find ways to make teaching an attractive career option to talented young adults and to professionals interested in career change. We must find ways to update the knowledge and skills of persons who have entered teaching careers and to recharge their energy and enthusiasm about teaching. Although the Houston schools have reduced staff turnover by offering science

and math teachers substantial salary bonuses, most school systems are prevented from paying higher salaries to their best teachers or teachers in shortage subject areas by collective bargaining agreements and, in California, by state court rulings that forbid differentiated salary schedules. The Houston schools are also planning to create a "teacher technologist" position to attract people with a background in computers who would divide their time between teaching and assisting science and math teachers who are less familiar with computers. We applaud their efforts to confront the problem and search for creative solutions rather than simply deploring the teacher shortages and saying that they can't compete with industry.

We would also urge that a concerted effort be made to upgrade minority students' precollegiate training in science and math. The trends analysis indicates that minority students who enter college expressing an interest in scientific and technical fields have a weaker academic background than white students, on average. The longitudinal analysis shows that Black and Hispanic women are more likely than white women to switch from science to nonscience majors during the undergraduate years.

The women we interviewed believe that if more girls only knew about scientific and technical fields, knew that women could and do succeed in them, had a solid high school background in science and math and understood that "just because you can get an 'A' in English and a 'B' in math doesn't necessarily mean you should go into English," far more of them would enter scientific and technical fields. We believe that "hands-on" experience conducting research or using math to address a real technical problem is also critical to pursuing a scientific or technical career.

"Hands-on" Experience

It's actively "doing" not reading science textbooks, memorizing laws of physics, the periodic table of elements, or theorems, or working through a set of problems at the end of a chapter that generates enthusiasm for science, math, and engineering. The comments and experiences of our respondents underscore the importance of involving young people in doing experiments, working with practicing researchers, and being a member of a research or technical team. Some remember high school teachers who allowed them to work in the lab or to use computer terminals after school, others participated in special programs for science-oriented high school students, often NSF-sponsored summer programs. As college students, many had opportunities to work on a professor's research project as a work-study student or volunteer, were required to fulfill independent research requirements, or worked in labs as summer interns, co-op education students, or as participants in an off-campus program. They describe these experiences as invaluable.

Young people should be provided with these kinds of opportunities and encouraged to take advantage of them. We are concerned that proposed cuts in NSF's science education budget will severely curtail many opportunities to participate in these kinds of programs. We are especially concerned that elementary, junior high, and high school students have an opportunity to get hooked on science and math so that they will take the elective courses that are prerequisites for undergraduate majors in scientific and technical fields.

Retention

What can we do to encourage young women who do express an interest in scientific and technical fields to pursue these interests during college and graduate school? Obviously, continued exposure to role models, career information, and opportunities to work on research projects, technical teams, and

in labs are all important. We also feel that these young women should be strongly advised to attend schools with good science facilities and active research programs. None of the women we interviewed had attended a community college and we are encouraged by the fact that the trends analysis shows an increase in the proportions of minority students selecting universities and private institutions. However, we anticipate that the cuts in student financial aid programs proposed by the Reagan administration will result in a dramatic shift in student enrollment toward the public sector and low-cost community colleges, particularly among students from low-income families. Some private colleges have already announced that they can no longer admit students regardless of financial need, and tuition at private institutions has risen to levels that are prohibitively high even for many middle-class families. We must advise young people and their parents about the importance of the college choice process, about the ways in which they might meet their share of educational expenses, and about financial aid opportunities. Certainly, we hope that the cuts in federal programs will not be as severe as anticipated, because an opportunity to attend some college is not an opportunity to have the kind of educational experience it takes to succeed in scientific and technical fields.

Similarly, we are concerned about the effects that proposed cutbacks in financial aid for graduate study will have, that reduced federal support for university-based research is having on the availability of research and teaching assistantships, and that the phasing out of programs like the Ford Fellowships are having on enrollments in advanced degree programs. Few of the women we interviewed could or would have pursued advanced degrees without substantial financial aid. Graduate education is expensive and far too time-consuming to permit students to hold off-campus jobs.

We believe that increased representation of women and minority faculty members in scientific and technical fields will have direct and indirect benefits for women and minority students. These faculty members not only provide role models, but they often are especially concerned about recruiting and retaining talented women and minority students. They can influence departmental attitudes. It is ironic that the women we interviewed who are interested in academic careers, committed to teaching, and who appear to be very talented scientists completed their training at a time when the academic labor market offered few openings. We hope that they will persevere in their search for faculty positions and that colleges and universities will actively recruit them, abiding by the spirit rather than the letter of affirmative action. There is no question in our minds that these women are highly qualified, competitive candidates for any faculty opening in their field. Unfortunately, there is also evidence to suggest that some departments hire women only with great reluctance, that search committees sometimes collect women's resumes just to show the affirmative action office that they tried, or that, once a department has hired a woman, it may assume that it has met its "quota."

Our interview respondents want to be assessed on their professional merit without regard to their gender, race, or ethnicity. We wish that there was reason to believe that this was how things worked in the world of work. Three recent reports from the National Research Council (1979, 1980, and 1981) indicate that woman doctorates face persisting inequities in the academic labor market, in government jobs, and in industry.

Conclusion

Increasingly, women are expressing interest and pursuing careers in scientific and technical fields. We believe that progress is being made in

the effort to reduce and eliminate the barriers that have prevented many young women from considering careers in these fields. We are encouraged by the still small but steadily growing numbers of women engineers, scientific researchers, medical professionals, and college faculty members in scientific and technical fields and by their enthusiasm about their work. There is still much that can be done to encourage young women to expand their career awareness and to acquire the skills and educational background necessary to pursue scientific and technical training. We believe that educators and educational institutions can play a major role in this process. Young women should be provided with enough career information, exposure to research and professionals in scientific and technical fields, and a strong enough academic background to enable them to make affirmative career decisions rather than leaving them to choose among the alternatives that are left after they have prematurely foreclosed their options.

References

American Council on Education, Staff of the Office of Research. The American College Freshman: National Norms for Fall 1971. Washington: ACE, 1971.

Astin, A.W. Preventing Students from Dropping Out. San Francisco: Jossey-Bass, 1975.

Astin, A.W. Four Critical Years. San Francisco: Jossey-Bass, 1977.

Astin, A.W. et al. Minorities in American Higher Education. San Francisco: Jossey-Bass, 1982.

Astin, A.W., M.R. King, J.M. Light, and G.T. Richardson. The American Freshman: National Norms for Fall 1973. Los Angeles: Graduate School of Education, University of California, 1973.

Astin, A.W., M.R. King, and G.T. Richardson. The American Freshman: National Norms for Fall 1975. Los Angeles: Graduate School of Education, University of California, 1975.

Astin, A.W., M.R. King, and G.T. Richardson. The American Freshman: National Norms for Fall 1977. Los Angeles: Graduate School of Education, University of California, 1977.

Astin, A.W., M.R. King, and G.T. Richardson. The American Freshman: National Norms for Fall 1979. Los Angeles: Graduate School of Education, University of California, 1979.

Casserly, P.L. Factors affecting female participation in advanced placement programs in mathematics, chemistry, and physics. In L.H. Fox, L. Brody, and D. Tobin (Eds) Women and the Mathematical Mystique. Baltimore: Johns Hopkins University Press, 1980, pp. 136-163.

Fact-File: Engineers and Scientists at colleges. Chronicle of Higher Education, April 28, 1982, p. 10.

Fox, L.H. The Problem of Women and Mathematics. New York: Ford Foundation, 1981.

Malcom, S.M., P.Q. Hall, and J.W. Brown. The Double Bind: The Price of Being a Minority Woman in Science. Washington: American Association for the Advancement of Science, 1976.

National Research Council, Commission on Human Resources. Climbing the Academic Ladder: Doctoral Women Scientists. Washington: National Academy of Sciences, 1979.

National Research Council, Commission on Human Resources. Women Scientists in Industry and Government: How Much Progress in the 1970's? Washington: National Academy of Sciences, 1980.

National Research Council, Commission on Human Resources. Career Outcomes in a Matched Sample of Men and Women Ph.D.s. Washington: National Academy of Sciences, 1981.

National Science Foundation and Department of Education. Science and Engineering Education for the 1980's and Beyond. Washington: U.S. Government Printing Office, 1980.

Savage, D.G. Math, Science teacher shortage grows. Los Angeles Times, January 7, 1982, pp. 1, 15.

Scully, M.G. Entrance rules tightened at some public institutions. Chronicle of Higher Education, December 9, 1981, pp. 1, 13.

U.S. Bureau of the Census. Statistical Abstract of the United States: 1980. (101st edition). Washington: U.S. Government Printing Office, 1980.

Vetter, B.M. Opportunities in Science and Engineering. Washington: Scientific Manpower Commission, 1980.

Vetter, B.M. Women scientists and engineers: trends in participation. Science, 1981, 214 (18), pp. 1313-1321.

Appendix A:

CIRP Freshman Survey Form for 1971

YOUR NAME _____
(please print) First Middle or Maiden Last

HOME STREET ADDRESS _____
(print)

CITY _____ STATE _____
(print) (print) Zip Code (if known)

1971 STUDENT INFORMATION FORM

When were you born? 191944

Month (01-12) | Day (01-31) | Year

GRP.

Dear Student:

The information in this report is being collected as part of a continuing study of higher education by the American Council on Education. The Council, which is a non-governmental association of colleges and educational organizations, encourages and solicits your cooperation in this research in order to achieve a better understanding of how students are affected by their college experiences. Detailed information on the goals and design of this research program are furnished in research reports available from the Council. Identifying information has been requested in order to make subsequent mail follow-up studies possible. Your response will be held in the strictest professional confidence.

Sincerely yours, Logan Wilson

Logan Wilson, President

DIRECTIONS: Your responses will be read by an optical mark reader. Your careful observance of these few simple rules will be most appreciated:

Use only black lead pencil (No. 2½ or less).
Make heavy black marks that fill the circle.
Erase cleanly any answer you wish to change.
Make no stray markings of any kind.

	Yes	No
EXAMPLE: Will marks made with ball pen or fountain pen be properly read?	○	●

1. Your Sex:
Male ○
Female ○

2. Are you presently married?
Yes ○
No ○

3. How old will you be on December 31 of this year? (Mark one)
16 or younger ○
17 ○
18 ○
19 ○
20 ○
21 ○
22-25 ○
26 or older ○

4. What was your average grade in secondary school? (Mark one)
A or A+ ○
A- ○
B+ ○
B ○
B- ○
C+ ○
C ○
D ○

5. Where did you rank academically in your high school graduating class? (Mark one)
Top Quarter ○
2nd Quarter ○
3rd Quarter ○
4th Quarter ○

6. Did you graduate from secondary school in the class of 1971?
Yes ○
No ○

7. Are you a veteran? (Mark one)
No ○
Yes, I served in Southeast Asia ○
Yes, but I did not serve in Southeast Asia ○

8. Mark one:
This is the first time I have enrolled in college as a freshman ○
I have attended this college before ○
I came to this college from a junior college ○
I came to this college from a four-year college or university ○

9. The following questions deal with accomplishments that might possibly apply to your high school years. Do not be discouraged by this list; it covers many areas of interest and few students will be able to say "yes" to many items.

(Mark all that apply)	Yes
Was elected president of one or more student organizations (recognized by the school)	○
Received a high rating (Good, Excellent) in a state or regional music contest	○
Participated in a state or regional speech or debate contest	○
Had a major part in a play	○
Won a varsity letter (sports)	○
Won a prize or award in an art competition	○
Edited the school paper, yearbook, or literary magazine	○
Had poems, stories, essays, or articles published	○
Participated in a National Science Foundation summer program	○
Placed (first, second, or third) in a state or regional science contest	○
Was a member of a scholastic honor society	○
Won a Certificate of Merit or Letter of Commendation in the National Merit Program	○

10. What is the highest academic degree that you intend to obtain? (Mark one)
None ○
Associate (A.A. or equivalent) ○
Bachelor's degree (B.A., B.S., etc.) ○
Master's degree (M.A., M.S., etc.) ○
Ph.D. or Ed.D. ○
M.D., D.O., D.D.S., or D.V.M. ○
LL.B. or J.D. (Law) ○
B.D. (Divinity) ○
Other ○

11. How many miles is this college from your home? (Mark one)
5 or less ○
6-10 ○
11-50 ○
51-100 ○
101-500 ○
More than 500 ○

12. What is the highest level of formal education obtained by your parents? (Mark one in each column)

	Father	Mother
Grammar school or less	○	○
Some high school	○	○
High school graduate	○	○
Some college	○	○
College degree	○	○
Postgraduate degree	○	○

13. Do you have any concern about your ability to finance your college education? (Mark one)
None (I am confident that I will have sufficient funds) ○
Some concern (but I will probably have enough funds) ○
Major concern (not sure I will be able to complete college) ○

14. For each item indicate if it is a source for financing your education. (Mark one in each row)

	Major Source	Minor Source	Not a Source
Part-time or summer work	O	O	O
Savings from full-time employment	O	O	O
Parental or family aid or gifts	O	O	O
Federal benefits from parent's military service	O	O	O
G.I. benefits from your military service	O	O	O
Scholarships and grants	O	O	O
NDEA loans, federally insured loans or college loans	O	O	O
Other repayable loans	O	O	O

15. What is your best estimate of the total income last year of your parental family (not your own family if you are married)? Consider annual income from all sources before taxes. (Mark one)

Less than $4,000	O	$15,000-$19,999	O
$4,000-$5,999	O	$20,000-$24,999	O
$6,000-$7,999	O	$25,000-$29,999	O
$8,000-$9,999	O	$30,000-$34,999	O
$10,000-$12,499	O	$35,000-$39,999	O
$12,500-$14,999	O	$40,000 or more	O

16. Are you: (Mark all that apply.)

White/Caucasian	O
Black/Negro/Afro-American	O
American Indian	O
Oriental	O
Mexican-American/Chicano	O
Puerto Rican-American	O
Other	O

17. Mark one in each column:

	Religion in Which You Were Reared	Your Present Religious Preference
Protestant	O	O
Roman Catholic	O	O
Jewish	O	O
Other	O	O
None	O	O

18. In deciding to go to college, how important to you was each of the following reasons? (Mark one answer for each reason)

	Very important	Somewhat important	Not important
My parents wanted me to go	V	S	N
To be able to contribute more to my community	V	S	N
To be able to get a better job	V	S	N
To gain a general education and appreciation of ideas	V	S	N
To improve my reading and study skills	V	S	N
There was nothing better to do	V	S	N
To make me a more cultured person	V	S	N
To be able to make more money	V	S	N
To learn more about things that interest me	V	S	N
To meet new and interesting people	V	S	N
To prepare myself for graduate or professional school	V	S	N

19. Below is a general list of things that students sometimes do. Indicate which of these things you did during the past year in school. If you engaged in an activity frequently, mark (F). If you engaged in an activity one or more times, but not frequently, mark (O) (occasionally). Mark (N) (not at all) if you have not performed the activity during the past year. (Mark one for each item)

	Frequently	Occasionally	Not at all
Voted in a student election	F	O	N
Came late to class	F	O	N
Played a musical instrument	F	O	N
Studied in the library	F	O	N
Checked out a book or journal from the school library	F	O	N
Arranged a date for another student	F	O	N
Overslept and missed a class or appointment	F	O	N
Read about collegiate rights and responsibilities of students	F	O	N
Typed a homework assignment	F	O	N
Discussed my future with my parents	F	O	N
Failed to complete a homework assignment on time	F	O	N
Argued with a teacher in class	F	O	N
Attended a religious service	F	O	N
Demonstrated for a change in some racial or ethnic policy	F	O	N
Demonstrated for a change in some military policy	F	O	N
Demonstrated for a change in some administrative policy of my high school	F	O	N
Did extra (unassigned) reading for a course	F	O	N
Took sleeping pills	F	O	N
Tutored another student	F	O	N
Played chess	F	O	N
Read poetry not connected with a course	F	O	N
Took a tranquilizing pill	F	O	N
Discussed religion	F	O	N
Took vitamins	F	O	N
Visited an art gallery or museum	F	O	N
Worked in a school political campaign	F	O	N
Worked in a local, state, or national political campaign	F	O	N
Missed school because of illness	F	O	N
Smoked cigarettes	F	O	N
Discussed politics	F	O	N
Drank beer	F	O	N
Discussed sports	F	O	N
Read about civil rights and liberties	F	O	N
Asked a teacher for advice after class	F	O	N
Had vocational counseling	F	O	N
Stayed up all night	F	O	N

20. How would you characterize your political views? (Mark one)

Far left	O
Liberal	O
Middle-of-the-road	O
Conservative	O
Far right	O

21. Mark only three responses, one in each column.

Your probable career occupation.
Your father's occupation.
Your mother's occupation.

Y F M

NOTE: If your father (or mother) is deceased, please indicate his (her) last occupation.

	Y	F	M
Accountant or actuary	Y	F	M
Actor or entertainer	Y	F	M
Architect	Y	F	M
Artist	Y	F	M
Business (clerical)	Y	F	M
Business executive (management, administrator)	Y	F	M
Business owner or proprietor	Y	F	M
Business salesman or buyer	Y	F	M
Clergyman (minister, priest)	Y	F	M
Clergy (other religious)	Y	F	M
Clinical psychologist	Y	F	M
College teacher	Y	F	M
Computer programmer	Y	F	M
Conservationist or forester	Y	F	M
Dentist (including orthodontist)	Y	F	M
Dietitian or home economist	Y	F	M
Engineer	Y	F	M
Farmer or rancher	Y	F	M
Foreign service worker (including diplomat)	Y	F	M
Housewife	Y	F	M
Interior decorator (including designer)	Y	F	M
Interpreter (translator)	Y	F	M
Lab technician or hygienist	Y	F	M
Law enforcement officer	Y	F	M
Lawyer (attorney)	Y	F	M
Military service (career)	Y	F	M
Musician (performer, composer)	Y	F	M
Nurse	Y	F	M
Optometrist	Y	F	M
Pharmacist	Y	F	M
Physician	Y	F	M
School counselor	Y	F	M
School principal or superintendent	Y	F	M
Scientific researcher	Y	F	M
Social worker	Y	F	M
Statistician	Y	F	M
Therapist (physical, occupational, speech)	Y	F	M
Teacher (elementary)	Y	F	M
Teacher (secondary)	Y	F	M
Veterinarian	Y	F	M
Writer or journalist	Y	F	M
Skilled trades	Y	F	M
Other	Y		
Undecided	Y		
Laborer (unskilled)		F	M
Semi-skilled worker		F	M
Other occupation		F	M
Unemployed		F	M

22. Rate yourself on each of the following traits as you really think you are when compared with the average student of your own age. We want the most accurate estimate of how you see yourself. (Mark one for each item)

Trait	Highest 10 Percent	Above Average	Average	Below Average	Lowest 10 Percent
Academic ability	O	O	O	O	O
Athletic ability	O	O	O	O	O
Artistic ability	O	O	O	O	O
Cheerfulness	O	O	O	O	O
Defensiveness	O	O	O	O	O
Drive to achieve	O	O	O	O	O
Leadership ability	O	O	O	O	O
Mathematical ability	O	O	O	O	O
Mechanical ability	O	O	O	O	O
Originality	O	O	O	O	O
Political conservatism	O	O	O	O	O
Political liberalism	O	O	O	O	O
Popularity	O	O	O	O	O
Popularity with the opposite sex	O	O	O	O	O
Public speaking ability	O	O	O	O	O
Self-confidence (intellectual)	O	O	O	O	O
Self-confidence (social)	O	O	O	O	O
Sensitivity to criticism	O	O	O	O	O
Stubbornness	O	O	O	O	O
Understanding of others	O	O	O	O	O
Writing ability	O	O	O	O	O

23. Mark one in each row: { Agree Strongly / Agree somewhat / Disagree somewhat / Disagree strongly }

	Agree strongly	Agree somewhat	Disagree somewhat	Disagree strongly
The Federal government is not doing enough to control environmental pollution	O	O	O	O
The Federal government is not doing enough to protect the consumer from faulty goods and services	O	O	O	O
The Federal government is not doing enough to promote school desegregation	O	O	O	O
There is too much concern in the courts for the rights of criminals	O	O	O	O
The death penalty should be abolished	O	O	O	O
The activities of married women are best confined to the home and family	O	O	O	O
The "generation gap" between me and my parents is so great that we can barely communicate	O	O	O	O
Marijuana should be legalized	O	O	O	O
Parents should be discouraged from having large families	O	O	O	O
Women should receive the same salary and opportunities for advancement as men in comparable positions	O	O	O	O
Everybody should be given an opportunity to go to college regardless of past performance or aptitude test scores	O	O	O	O
Realistically, an individual person can do little to bring about changes in our society	O	O	O	O

24. Mark one in each row: { Agree strongly / Agree somewhat / Disagree somewhat / Disagree strongly }

	Agree strongly	Agree somewhat	Disagree somewhat	Disagree strongly
College officials have the right to regulate student behavior off campus	O	O	O	O
The chief benefit of a college education is that it increases one's earning power	O	O	O	O
Faculty promotions should be based in part on student evaluations	O	O	O	O
College grades should be abolished	O	O	O	O
Colleges would be improved if organized sports were de-emphasized	O	O	O	O
Student publications should be cleared by college officials	O	O	O	O
College officials have the right to ban persons with extreme views from speaking on campus	O	O	O	O
Students from disadvantaged social backgrounds should be given preferential treatment in college admissions	O	O	O	O
Most college officials have been too lax in dealing with student protests on campus	O	O	O	O
Open admissions (admitting anyone who applies) should be adopted by all publicly-supported colleges	O	O	O	O
Even if it employs open admissions, a college should use the same performance standards in awarding degrees to all students	O	O	O	O

25. What is your best guess as to the chances that you will: (Mark one for each item)

	Very Good Chance	Some Chance	Very Little Chance	No Chance
Get married while in college?	O	O	O	O
Get married within a year after college?	O	O	O	O
Vote in the 1972 presidential election?	O	O	O	O
Enlist in the armed services before graduating?	O	O	O	O
Change major field?	O	O	O	O
Change career choice?	O	O	O	O
Fail one or more courses?	O	O	O	O
Graduate with honors?	O	O	O	O
Be elected to a student office?	O	O	O	O
Join a social fraternity, sorority, or club?	O	O	O	O
Be elected to an academic honor society?	O	O	O	O
Make at least a "B" average?	O	O	O	O
Need extra time to complete your degree requirements?	O	O	O	O
Have to work at an outside job?	O	O	O	O
Seek vocational counseling?	O	O	O	O
Seek individual counseling on personal problems?	O	O	O	O
Enroll in honors courses?	O	O	O	O
Get tutoring help in specific courses?	O	O	O	O
Author or co-author a published article?	O	O	O	O
Be more successful after graduation than most students attending this college?	O	O	O	O
Drop out of this college temporarily (exclude transferring)?	O	O	O	O
Drop out permanently (exclude transferring)?	O	O	O	O
Transfer to another college before graduating?	O	O	O	O
Be satisfied with your college?	O	O	O	O

26. Do you feel that you will need any special tutoring or remedial work in any of the following subjects? (Mark all that apply)

English O Mathematics O Science O
Reading O Social studies O Foreign language O

27. Below is a list of 68 different undergraduate major fields grouped into general categories. Mark only three of the 68 fields as follows:

① First choice (your probable major field of study).
② Second choice.
Ⓛ The field of study which is least appealing to you.

ARTS AND HUMANITIES

Architecture	① ② Ⓛ
English (literature)	① ② Ⓛ
Fine arts	① ② Ⓛ
History	① ② Ⓛ
Journalism (writing)	① ② Ⓛ
Language (modern)	① ② Ⓛ
Language (other)	① ② Ⓛ
Music	① ② Ⓛ
Philosophy	① ② Ⓛ
Speech and drama	① ② Ⓛ
Theology	① ② Ⓛ
Other	① ② Ⓛ

BIOLOGICAL SCIENCE

Biology (general)	① ② Ⓛ
Biochemistry	① ② Ⓛ
Biophysics	① ② Ⓛ
Botany	① ② Ⓛ
Zoology	① ② Ⓛ
Other	① ② Ⓛ

BUSINESS

Accounting	① ② Ⓛ
Business admin.	① ② Ⓛ
Electronic data processing	① ② Ⓛ
Secretarial studies	① ② Ⓛ
Other	① ② Ⓛ

ENGINEERING

Aeronautical	① ② Ⓛ
Civil	① ② Ⓛ
Chemical	① ② Ⓛ
Electrical	① ② Ⓛ
Industrial	① ② Ⓛ
Mechanical	① ② Ⓛ
Other	① ② Ⓛ

PHYSICAL SCIENCE

Chemistry	① ② Ⓛ
Earth science	① ② Ⓛ
Mathematics	① ② Ⓛ
Physics	① ② Ⓛ
Statistics	① ② Ⓛ
Other	① ② Ⓛ

PROFESSIONAL

Health Technology (medical, dental, laboratory)	① ② Ⓛ
Nursing	① ② Ⓛ
Pharmacy	① ② Ⓛ
Predentistry	① ② Ⓛ
Prelaw	① ② Ⓛ
Premedical	① ② Ⓛ
Preveterinary	① ② Ⓛ
Therapy (occupat., physical, speech)	① ② Ⓛ
Other	① ② Ⓛ

SOCIAL SCIENCE

Anthropology	① ② Ⓛ
Economics	① ② Ⓛ
Education	① ② Ⓛ
History	① ② Ⓛ
Political Science (government, int. relations)	① ② Ⓛ
Psychology	① ② Ⓛ
Social work	① ② Ⓛ
Sociology	① ② Ⓛ
Other	① ② Ⓛ

OTHER FIELDS

Agriculture	① ② Ⓛ
Communications (radio, T.V., etc.)	① ② Ⓛ
Computer Science	① ② Ⓛ
Environmental Science	① ② Ⓛ
Electronics (technology)	① ② Ⓛ
Forestry	① ② Ⓛ
Home economics	① ② Ⓛ
Industrial arts	① ② Ⓛ
Library science	① ② Ⓛ
Military science	① ② Ⓛ
Physical education and recreation	① ② Ⓛ
Other (technical)	① ② Ⓛ
Other (nontechnical)	① ② Ⓛ
Undecided	① ② Ⓛ

Please be sure that only three circles have been marked in the above list.

28. Indicate the importance to you personally of each of the following: (Mark one for each item)

	Essential	Very important	Somewhat important	Not important
Becoming accomplished in one of the performing arts (acting, dancing, etc.)	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Becoming an authority in my field	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Obtaining recognition from my colleagues for contributions in my special field	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Influencing the political structure	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Influencing social values	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Raising a family	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Having an active social life	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Having friends with different backgrounds and interests from mine	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Becoming an expert in finance and commerce	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Having administrative responsibility for the work of others	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Being very well-off financially	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Helping others who are in difficulty	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Participating in an organization like the Peace Corps or Vista	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Becoming a community leader	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Making a theoretical contribution to science	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Writing original works (poems, novels, short stories, etc.)	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Never being obligated to people	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Creating artistic work (painting, sculpture, decorating, etc.)	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Keeping up to date with political affairs	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Being successful in a business of my own	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Becoming involved in programs to clean up the environment	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Developing a meaningful philosophy of life	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Participating in a community action program	Ⓔ	Ⓥ	Ⓢ	Ⓝ
Getting married within the next five years	Ⓔ	Ⓥ	Ⓢ	Ⓝ

29. Below are some of the reasons that might have influenced your decision to attend this particular college. How important was each reason in deciding to come here?
(Mark one answer for each statement.)

	Very important	Somewhat important	Not important
My relatives wanted me to come here	Ⓥ	Ⓢ	Ⓝ
This college has a very good reputation	Ⓥ	Ⓢ	Ⓝ
Most of my friends are going to this college	Ⓥ	Ⓢ	Ⓝ
Because of low tuition	Ⓥ	Ⓢ	Ⓝ
Someone who had been here before advised me to go	Ⓥ	Ⓢ	Ⓝ
Because of the special educational programs offered	Ⓥ	Ⓢ	Ⓝ
I was not accepted anywhere else	Ⓥ	Ⓢ	Ⓝ
My guidance counselor advised me to go	Ⓥ	Ⓢ	Ⓝ
I wanted to live at home	Ⓥ	Ⓢ	Ⓝ

DIRECTIONS:

The remaining circles are provided for items specifically designed by your college, rather than by the American Council on Education. If your college has chosen to use the circles, observe carefully the supplemental directions given you.

		DO NOT MARK
30.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	0 0 0 0 0 0
31.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	1 1 1 1 1 1
32.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	2 2 2 2 2 2
33.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	3 3 3 3 3 3
34.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	4 4 4 4 4 4
35.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	5 5 5 5 5 5
36.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	6 6 6 6 6 6
37.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	7 7 7 7 7 7
38.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	8 8 8 8 8 8
39.	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	9 9 9 9 9 9
		① ② ③ ④ Ⓐ

Prepared by Office of Research, American Council on Education, One Dupont Circle N.W., Washington, D.C. 20036. Processed by Intran Corporation, 4555 W. 77th St., Minneapolis, Minn. 55435

Appendix B:

HERI 1980 Follow-Up Survey

79/80

FOLLOW-UP OF 1971 ENTERING FRESHMEN

HIGHER EDUCATION RESEARCH INSTITUTE • P.O. BOX 35559 • MINNEAPOLIS, MINNESOTA 55435

NAME & ADDRESS CORRECTION:

Your Name

First Middle or Maiden Last

Home Street Address

City State

ZIP Code

DIRECTIONS: Your responses will be read by an optical mark reader. Your careful observance of these few simple rules will be most appreciated.

- Use only a black lead pencil (no. 2½ or less).
- Make heavy black marks that fill the circle.
- Erase cleanly any answer you wish to change.
- Make no stray markings of any kind.
- Where write-in responses are necessary, please confine your writing to the limits of the lines provided.

EXAMPLE: Will marks made with ball-point or felt-tip pen be properly read? ○ Yes ● No

1. Please indicate: (Mark one in each column)

	(A) the highest degree you now hold	(B) the degree (if any) you are now working toward	(C) the highest degree you plan to receive	(D) the highest degree your spouse holds
High school diploma (or equivalent)	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Vocational training certificate	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Associate's	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Bachelor's	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Master's (M.A., M.S., M.B.A., M.F.A., etc.)	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Doctorate (Ph.D. or Ed.D.)	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Advanced professional (MD, DDS, DVM, JD, LLD)	Ⓐ	Ⓑ	Ⓒ	Ⓓ
Not married				Ⓓ

2. From what type of high school did you graduate?

○ Public high school in U.S.
○ Private religious (parochial) high school in U.S.
○ Private non-religious high school in U.S.
○ Public high school outside U.S.
○ Private high school outside U.S.

3. Were you in a college preparatory program in high school?

○ Yes ○ No ○ Don't remember

4. How many children do you have?

○ None ○ Two
○ One ○ Three or more

5. What is your citizenship status?

○ U.S. native
○ U.S. naturalized
○ Immigrant, permanent U.S. resident
○ Foreign citizen on temporary visa

6. Where were you and your parents born?

	You	Father	Mother
U.S. native	○	○	○
U.S. territory (e.g., Puerto Rico, Guam, Samoa)	○	○	○
Foreign country	○	○	○

7a. Have you ever been married? (Mark one)

○ No
○ Yes, now living with spouse
○ Yes, but am now separated, divorced, or widowed

7b. When were you first married?

○ Before entering college in 1971 ○ After leaving college
○ While I was an undergraduate

THE FOLLOWING QUESTIONS (8-17) ARE ABOUT YOUR UNDERGRADUATE EXPERIENCE. UNLESS OTHERWISE SPECIFIED, COLLEGE REFERS TO THE LAST UNDERGRADUATE COLLEGE YOU ATTENDED.

8. Write in the name of the college you last attended as an undergraduate.

Name of College

City State

11	12
⓪ ⓪ ⓪ ⓪	⓪ ⓪
① ① ① ①	① ①
② ② ② ②	② ②
③ ③ ③ ③	③ ③
④ ④ ④ ④	④ ④
⑤ ⑤ ⑤ ⑤	⑤ ⑤
⑥ ⑥ ⑥ ⑥	⑥ ⑥
⑦ ⑦ ⑦ ⑦	⑦ ⑦
⑧ ⑧ ⑧ ⑧	⑧ ⑧
⑨ ⑨ ⑨ ⑨	⑨ ⑨

9. What was your last major in college? (Be specific; for example, state which specialty of engineering)

10. How many different colleges did you attend as an undergraduate?

○ One ○ Two ○ Three ○ Four or more

11. Altogether, how many academic years did you complete: (Mark one on each line)

	Less than 1 yr.	1 yr.	2 yrs.	3 yrs.	4 or more yrs.
College entered in 1971?	○	○	○	○	○
Last undergraduate college attended?	○	○	○	○	○

12. When you first entered college, how well prepared were you compared to most other students at your college?

(Mark one on each row)	Better prepared than most	About as well prepared as most	Not as well prepared as most
Reading and comprehension	○	○	○
Writing	○	○	○
Mathematics	○	○	○
Natural sciences	○	○	○
Preparing research papers	○	○	○

13. What was your average undergraduate grade? (Mark one)

○ A+, A, A- ○ B-, C+ ○ C-, D+
○ B+, B ○ C ○ D or less

14. How satisfied were you with the following at your last undergraduate college? (Mark one in each row)

	Very Satisfied	Somewhat Satisfied	Not Satisfied	Available But I Did Not Take/Use	Not Available
Career counseling					
Personal counseling					
Tutoring					
Health services					
Job placement services					
Financial aid services					
Ethnic studies					
Women's studies					
EOP (Educational Opportunity Program)					
College's academic reputation					
Intellectual environment					
Quality of classroom instruction					
Faculty-student relations					
Variety of courses offered					
Friendships with other students					
The administration					

15. Did you: (Mark all that apply)

- Attend college part time for at least one term
- Know at least one professor or administrator personally
- Take more than four years to complete your Bachelor's degree
- Get elected president of one or more student organizations
- Serve on a university or departmental committee
- Have a major part in a play
- Win a varsity letter (sports)
- Edit the school paper, yearbook, or literary magazine
- Belong to a scholastic honor society
- Drop out for a period of time

16. Did you participate in any of the following? (Mark all that apply)

- NSSFNS
- Ford Foundation Upper Division Transfer program
- General Electric Upper Division program
- Upward Bound
- MESA (Minority Engineering Science Association)
- Talent Search
- A summer enrichment program (educational)
- Bureau of Indian Affairs program

17. Overall, how satisfied were you with: (Mark one on each line)

	Very Satisfied	Somewhat Satisfied	Not at all Satisfied
College entered in 1971			
Last undergraduate college attended			

IF YOU DROPPED OUT OF COLLEGE BEFORE EARNING A DEGREE OR VOCATIONAL CERTIFICATE, PLEASE ANSWER THE FOLLOWING QUESTIONS (18-19). OTHERWISE GO TO QUESTION 20.

18. What are the chances that you will return to college within the next two years? (Mark one)

- Very good
- Fairly good
- Not very good
- No chance

19. Do you now wish that you had stayed in college?

- Yes
- No

20. I am currently: (Mark one)

- Employed full time
- Employed part time
- Unemployed, looking for work
- Unemployed, not looking for work

21. Racial/Ethnic Group: (Mark one only)

- Asian-American/Oriental
- American Indian or Alaskan Native (tribe or band):
- Black/Afro-American
- Chicano/Mexican-American
- Puerto Rican-American/Puerto Rican
- White/Caucasian
- Other (specify):

22. How would you describe the racial composition of the high school you last attended and the neighborhood where you grew up?

	Completely non-White	Mostly non-White	Roughly half non-White	Mostly White	Completely White
High school I last attended					
Neighborhood where I grew up					

23. How many of your close friends and associates at work or school are White versus non-White?

	All non-White	Mostly non-White	Mostly White	All White
Close friends				
Associates				

THE FOLLOWING QUESTIONS (24-32) ARE ABOUT WORK ANSWER EACH QUESTION ABOUT YOUR CURRENT OR MOST RECENT JOB. IF YOU HAVE NEVER BEEN EMPLOYED SINCE LEAVING COLLEGE, GO TO QUESTION 33.

24. What is your current (or most recent) occupation or job?

25. What was the first full-time job you had after you last left college? (Name of occupation or job)

24	25
0 0	0 0
1 1	1 1
2 2	2 2
3 3	3 3
4 4	4 4
5 5	5 5
6 6	6 6
7 7	7 7
8 8	8 8
9 9	9 9

26. (A) What is your current annual income before taxes? If self-employed, indicate your annual earned income after adjusting for business expenses.

(B) What is your spouse's income? If not married, mark here→

(Mark one in each column)	(A) My Income	(B) Spouse's Income
None	○	○
Below $7,000	○	○
$7,000 - $9,999	○	○
$10,000 - $14,999	○	○
$15,000 - $19,999	○	○
$20,000 - $24,999	○	○
$25,000 - $29,999	○	○
$30,000 - $34,999	○	○
$35,000 - $39,999	○	○
$40,000 and over	○	○

27. What two undergraduate fields of study would you recommend for someone preparing himself/herself for your present job?

(field) _____

(field) _____

27

0 0	0 0
1 1	1 1
2 2	2 2
3 3	3 3
4 4	4 4
5 5	5 5
6 6	6 6
7 7	7 7
8 8	8 8
9 9	9 9

28. Is your current or most recent job related to your undergraduate major? (Mark one)

- ○ Yes, closely related
- ○ Yes, somewhat related
- ○ No, not related

29. Which category best describes the type of organization in which you are employed? (Mark one)

- ○ Commerce, finance, insurance, real estate
- ○ Retail or wholesale trade
- ○ Other business or service establishments
- ○ Manufacturing
- ○ Transportation or public utilities
- ○ Agriculture or forestry
- ○ Elementary or secondary school system
- ○ Human services organization (social welfare, health, etc.)
- ○ College, university, technical institute or professional school
- ○ U.S. government, civilian employee
- ○ State, local or other government
- ○ U.S. military service, active duty, or Commission Corps
- ○ Other, (specify): →

30. Approximately how many persons does your company or organization employ? (Mark one)

- ○ I work alone
- ○ Fewer than 10
- ○ 10 - 99
- ○ 100 - 999
- ○ 1,000 - 9,999
- ○ 10,000 - 24,999
- ○ 25,000 or more

31. How well did your college education prepare you for your present job? (Mark one)

- ○ Very well
- ○ Well
- ○ Fairly well
- ○ Not well

231

32. How satisfied are (were) you with the following aspects of your current (most recent) job? (Mark one in each row)

	Very Satisfied	Somewhat Satisfied	Not Satisfied
Overall	○	○	○
Income	○	○	○
Fringe benefits	○	○	○
Variety of activities	○	○	○
Working conditions (hours, location)	○	○	○
Decision-making power, responsibility	○	○	○
Competency of people you work with	○	○	○
Opportunities for promotion	○	○	○
Job security	○	○	○
Opportunity to be creative	○	○	○
Opportunity to use training or schooling	○	○	○
Opportunity to contribute to society	○	○	○
Challenge	○	○	○

33. Mark one answer next to each statement:

	Agree Strongly	Agree Somewhat	Disagree Somewhat	Disagree Strongly
The chief benefit of a college education is that it increases one's earning power	○	○	○	○
Faculty promotions should be based in part on student evaluations	○	○	○	○
College officials have the right to ban persons with extreme views from speaking on campus	○	○	○	○
Students from disadvantaged social backgrounds should be given preferential treatment in college admissions	○	○	○	○
Open admissions should be adopted by all publicly-supported colleges	○	○	○	○
Even if it employs open admissions, a college should use the same performance standards in awarding degrees to all students	○	○	○	○
Racial discrimination is no longer a major problem in America	○	○	○	○
Colleges and universities should not have responsibility for rectifying racial injustice	○	○	○	○
Any institution with a substantial number of minority students should offer an ethnic studies program	○	○	○	○
Increases in minority enrollments result in a lowering of academic standards	○	○	○	○

34. Rate yourself on each of the following traits as compared with the average person your age. We want the most accurate estimate of how you see yourself.
(Mark one in each row)

	Highest 10 Percent	Above Average	Average	Below Average	Lowest 10 Percent
Academic ability	○	○	○	○	○
Artistic ability	○	○	○	○	○
Drive to achieve	○	○	○	○	○
Leadership ability	○	○	○	○	○
Mathematical ability	○	○	○	○	○
Popularity	○	○	○	○	○
Popularity with the opposite sex	○	○	○	○	○
Public speaking ability	○	○	○	○	○
Self-confidence (intellectual)	○	○	○	○	○
Self-confidence (social)	○	○	○	○	○
Writing ability	○	○	○	○	○

35. How would you characterize your current political views? (Mark one)

- Far left
- Liberal
- Middle-of-the-road
- Conservative
- Far right

36. Indicate the importance to you personally of each of the following: (Mark one in each row)

	Essential	Very Important	Somewhat Important	Not Important
Influencing the political structure	○	○	○	○
Influencing social values	○	○	○	○
Raising a family	○	○	○	○
Being very well-off financially	○	○	○	○
Becoming a community leader	○	○	○	○
Being successful in a business of my own	○	○	○	○
Participating in a community action program	○	○	○	○
Helping others who are in difficulty	○	○	○	○
Becoming involved in programs to clean up the environment	○	○	○	○

IF YOU HAVE EVER ATTENDED GRADUATE OR PROFESSIONAL SCHOOL, ANSWER THE FOLLOWING QUESTIONS (37-41).

37. Name your current or most recent graduate or professional school and your field/major at that school.

Graduate or Professional School
Field/Major

38. How do you rate yourself academically among the students in your current (or most recent) graduate/professional program?

- Among the best
- Above average
- About average
- Below average

39. As a graduate or professional student, did you apply for or participate in any of the following programs?

	Received	Applied for, didn't get	Knew about but didn't apply
Fellowship (institutional funds)	○	○	○
Research assistantship	○	○	○
Administrative assistantship	○	○	○
Special fellowship:			
Ford Foundation	○	○	○
Woodrow Wilson	○	○	○
Danforth	○	○	○
Other (specify):	○	○	○
National Fellowship Fund	○	○	○
Council on Legal Education Opportunities (CLEO)	○	○	○

40. How satisfied are you with the following at your current (or last) graduate or professional school? (Mark one in each row)

	Very Satisfied	Somewhat Satisfied	Not Satisfied	Available, I did not use
Career counseling	○	○	○	○
Tutoring	○	○	○	○
Job placement	○	○	○	○
Financial aid	○	○	○	○
College's academic reputation	○	○	○	
Intellectual environment	○	○	○	
Faculty-student relations	○	○	○	
Quality of instruction	○	○	○	
Variety of courses offered	○	○	○	
Friendships with other students	○	○	○	
The administration	○	○	○	
Accessibility of faculty	○	○	○	
Faculty support of my work	○	○	○	
Ethnic composition of student body	○	○	○	
Ethnic composition of faculty	○	○	○	

41. The following statements reflect patterns of minority and White relations that have been observed on various college and university campuses. To what extent is each present on or descriptive of the campus of your graduate school or professional school? (Mark one in each row)

	Substantial	Some	Very Little	Don't Know
Trust between minority students and				
White students	○	○	○	○
The faculty	○	○	○	○
The administration	○	○	○	○
Trust among different ethnic minority groups	○	○	○	○
Racial conflict	○	○	○	○
Faculty concern with minority issues	○	○	○	○
Social interaction between minority students and				
White students	○	○	○	○
The faculty	○	○	○	○
The administration	○	○	○	○
Open discussion of minority issues	○	○	○	○

THANK YOU FOR PARTICIPATING!

Please return your completed questionnaire in the postage-paid envelope provided to: Higher Education Research Institute, P.O. Box 35559, Minneapolis, Minnesota 55435.

Computer Use Only	
37	0 1 2 3 4 5 6 7 8 9
	1 2 3 4 A

5916/2660-Intran-54321

Appendix C:

Interview Protocol

INTERVIEW PROTOCOL

1. When did you first become interested in [general field] and what was it that attracted your interest?

2. At what point [and age] did you begin to seriously consider a career in [field]? How did you learn about career options in [field]? When did you arrive at a definite commitment to this career?

3. What people or experiences encouraged your interest in [field] and in a career as a [professional]?

   b) Were there any discouraging people or experiences?

4. Science and mathematics are often seen as "male" fields, if for no other reason than because so few women have entered these fields. Did this perception or other people's acceptance of it ever cause you or lead others to question whether a career in [field] was "right" or appropriate for you?

   IF YES: [Probe for specific examples--family, peers, teachers, counselors, etc.]

   IF NO : That's fairly unusual. Can you tell me why you think this was never an issue?

EDUCATIONAL HISTORY

5. I'd like to go back to your experience in grade school and high school. Where did you go to school and what kinds of schools did you attend?

   [For each school, descriptive information should include: (a) urban or suburban or rural (b) public or private and, if private, control and boarding or day; (c) coed or single-sex; (d) rough sense of enrollment size; and (e) extent of student and faculty multi-racial/ethnic representation]

6. How would you characterize the instruction in science and mathematics that you received at the elementary level?

   b) And at the secondary level?

7. Was educational and career guidance offered in your high school?

   b) Did you receive this type of counseling and guidance? From whom? And how useful was it?

8. When you graduated from high school, what were your plans for continuing your education?

   b) Was there ever any question as to whether or not you would go to college?

9. How did you go about choosing a college and what were the considerations that influenced this decision? (e.g., finances, being close to or far away from home, reputation or quality of the academic program, where your friends were going to school or where family members had attended college, scholarship offers, etc.)

   b) Did you apply to more than one college?

   IF YES: Do you remember what schools you applied to, why you choose them, and where you were accepted?

   IF NO : Do you remember why you applied to only one school and if you were ever concerned about not being accepted there?

10. Did you enter college the fall following your high school graduation?

    IF NO: What did you do during the time between high school graduation and college entry?

11. As a freshman, where did you enroll in college?

    [Verify the institution's (a) state, (b) control (public or private), (c) predominant race/ethnicity of student body, (d) co-ed or single-sex institution, and (e) approximate enrollment size at that time]

    b) Were you a resident or a commuter student?

    c) Do you remember there being many women (minority) faculty members at [name of college]? What about in the [field] department?

    d) IF MINORITY IN A MAJORITY INSTITUTION: Were there many [race/ethnicity] students on campus? What about in the [field] department?

12. Were any programs or services offered to encourage or assist women or minority students who were interested in majoring in mathematics, science, or technical fields?

13. What was your college major? Was this your first declared major?

    IF NO: What was and when did you change majors?

14. Do you think that you were ever treated differently from other undergraduates in [field] because you were a woman?

    IF MINORITY IN A MAJORITY INSTITUTION: Were you treated any differently because you were [race/ethnicity]?

    IF YES TO EITHER: How? Can you give me some examples?

15. Did undergraduates have opportunities to work on faculty research programs? Did you?

16. Did the fact that you were a [field] major affect how other students perceived or responded to you?

    b) What about other students in your major field?

17. Was your interest in [field] encouraged or discouraged in any way during your undergraduate years?

    IF YES: How and by whom?

18. Did you ever ask for or get advice or guidance from your professors about what educational and career options you should consider once you earned your bachelor's degree?

19. Did you work while you were an undergraduate?

    IF YES: Did your work contribute to your educational experience in any way beyond helping you to meet your expenses?

    [Job-related information should include: (a) type(s) of work; (b) summer versus school-year jobs; (c) full- or part-time work; (d) number of years worked and which years; (e) on-campus or off-campus; and (f) relationship of job to academic and career interests]

20. How long did it take you to earn a bachelor's degree?

    b) Did you ever attend school part-time, dropout of school for a period of time, or transfer to another college?

    IF YES TO ANY: Why [for each that applies]?

    IF TRANSFERRED: Where? When did you transfer?

21. As an undergraduate, were you involved in any extracurricular activities?

22. When did you first begin to consider going on for an advanced degree? What or who started you thinking about it? When did you definitely decide that you were going to go on for an advanced degree and what degree did you decide that you were going to get?

23. Did you go directly into graduate/professional school after earning your bachelor's degree? What year did you start?

    IF NO: What did you do after college until you entered graduate school?

24. Tell me how you went about choosing a graduate/professional program and deciding what school you would go to. What factors were important to your decision and what resources and people did you go to for information and help in making this decision?

    b) What schools did you apply to? Why? Where were you accepted?

    IF MORE THAN ONE APPLICATION AND ACCEPTANCE: How did you make your choice?

25. You said that as an undergraduate you felt that your professors [did/did not] treat you differently from other [field] majors because you were a woman. Was your experience in graduate/professional school similar or different and in what respects?

    IF MINORITY IN A MAJORITY INSTITUTION: And do you think that you were treated differently because you are [race/ethnicity]?

    IF YES TO BOTH: Two characteristics differentiated you from the typical graduate student in [field]. Do you think you were treated differently more as a result of your sex or because you were [race/ethnicity]?

26. Were there other women students in the [field] department/program?

    b) Did any women teach in the department/program?

    IF MINORITY IN A MAJORITY INSTITUTION: Were there other [race/ethnicity] students in the department/program? Were any of the [field] professors [race/ethnicity]?

27. How did other students respond to you as a [race/ethnicity] woman majoring in [field]?

28. Did graduate students in [field] usually work as faculty research assistants and/or receive fellowship support? And did you?

29. How did you finance your education and meet your living expenses while you were in graduate/professional school?

    IF WORKED: Could you tell me about the jobs you held?

    b) Were finances a major concern or problem for you?

30. Did any professor take a particular interest in your educational progress and career development?

    b) Was this pretty much typical for the students in your department/program?

31. Did you ask for or receive any advice or help from any of your professors about job or postdoc opportunities and what steps you should be taking to advance your career?

32. Did you ever consider changing fields in graduate school, transferring to a different institution, or dropping out altogether?

    IF YES TO ANY: Why and what happened? (for all that apply)

33. Did your degree goals or your career plans change in any way during the time that you were in graduate school?

    IF YES: In what ways and why did your goals change?

34. Did you complete you degree before, at about the same time, or after the majority of students in your entering class?

35. Is there any aspect of your educational experience or anything that happened to you during that period of your life that you feel was important to your career interests or plans that I haven't asked about?

36. What characteristics or qualities do you feel explain or contributed to your success?

EMPLOYMENT
(IF STILL IN SCHOOL, SKIP TO QUESTION 43)

37. I'd like to hear about your experience looking for your first job after graduate/professional school. When did you begin looking for a job and how did you go about it?

b) What kind of job were you looking for? When had you decided that this was the type of job you wanted and why did you choose it?

c) Were you open to relocating anywhere in the country or were you looking for a job in particular location or area of the country?

IF RESTRICTED: Why? Did this affect the type of job you looked for or the job options that were available to you?

d) What other factors influenced you decisions to apply for or accept a particular job or jobs?

38. Do you think that affirmative action requirements had any effect on your job search and its outcomes, in terms of the numbers of job interviews or offers you had or in the types of jobs you were offered?

b) How did your job search experience compare with that of your male peers from the [field] department/program? As far as you know, did you receive a comparable number of job offers? Were you offered the same types of jobs and were your salary offers equivalent?

39. IF NO LONGER IN FIRST JOB: Were you satisfied with your first job? How long did you stay in it and why did you change jobs?

b) What was your next job? (IF SECOND JOB IS NOT CURRENT JOB, REPEAT THIS ITEM UP TO CURRENT JOB).

40. How do you like your current job? What do you like most about it? Is there any aspect of your work that you are dissatisfied with?

b) Are your responsibilities the same as those of men in equivalent positions with equivalent backgrounds and experience?

c) Do you feel that you're treated differently than your male peers?

IF YES: In what ways are you treated differently and by whom?

41. Do you work with or have any regular contact with other women professionals?

    IF MINORITY: Do you work with other [race/ethnicity] women? Men?

42. Do you think that you've had to deal with problems in your professional experience that a man in your position would not have encountered?

43. If you had you educational and career decisions to make over again, would you do anything differently?

    IF YES: [Ask her to explain and after each ask: Is there anything else?]

44. Do you expect to continue working as a _____ throughout your career? How do you anticipate that your career will develop in the future? Is this also what you would most like to have happen?

45. Would you recommend a career in [field] to young women in high school and college? Why/Why not?

    b) Why do you think so few women express interest in scientific and technical fields? What could or should be done to encourage more young women to consider careers in these fields and in [interviewee's field] in particular?

BACKGROUND

46. Can you tell me about your family background and where you lived while you were growing up?

    [Information should include: (a) number of older and younger brothers and sisters; (b) parents married or separated; (c) father's occupation; (d) mother's occupation; (e) whether her mother worked while she was growing up; (f) father's highest level of education; (g) mother's highest level of education; (h) older siblings' education; (i)family's financial status (j) language(s) spoken in the home and (k) presence of extended family in the community.]

47. Did you know any women or any [professionals in her field] while you were growing up whose accomplishments you admired and who you wanted to be like when you grew up?

48. Did you expect that you would work when you grew up? Did your family?

49. What was your family's initial reaction to your interest in becoming a [job type]? Did this change over time in any way?

50. Have you ever married?

    IF YES: When did you get married?

    IF CURRENTLY MARRIED: What does your husband do? Is he supportive of your career? How are household chores shared?

51. Do you have children?

IF YES: [Number of children and their ages]
How did the arrival of children affect your career?

I've asked all of the questions that I wanted to be sure to cover. Do you have anything that you would like to add?

SUMMARY INFORMATION

Name:

Academic Status: Field/discipline
Highest earned degree or degree working toward
Last/current institution

Employment Status: Job title
Employer

Current Primary Involvement: School (student) or work (professional)